A Survey Related to Childhood Acute Lymphocytic Leukemia Whatcom County, Washington

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WHATCOM COUNTY HEALTH & HUMAN SERVICES

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TABLE OF CONTENTS

Executive Summary

Background

Leukemia is a cancer of the bone marrow and blood, characterized by the uncontrolled growth of specific types of white blood cells. While leukemia occurs about 10 times more often in adults than in children, it is the leading cause of childhood cancer. Acute lymphocytic leukemia (ALL) is one of four major types of leukemia.

Introduction

In November 1997, a parent of a child with ALL from Whatcom County contacted the Washington State Department of Health (DOH) Office of Epidemiology. The parent was concerned about the number of children with leukemia in areas of north and west Whatcom County. This concern was related to issues of water quality. Since the mid-1980s, wells in the area were known to be contaminated with ethylene dibromide (EDB) and 1,2, dichloropropane (1,2 DCP).

DOH reviewed cancer registry and hospital discharge data and found the number of children with ALL in this geographic area was statistically significantly greater than expected, especially for children less than five years old between 1992 and 1994. Based on these findings, DOH provided assistance to the Whatcom County Health and Human Services Department (HHS) in conducting a survey. The goal of the survey was to seek to identify common exposures in Custer (98240), Everson (98247), Ferndale (98248), Lynden (98264), Sumas (98295), and rural Bellingham (98226) that might be related to the development of ALL.

Methods

HHS, working with community members, DOH, and the medical records staff at St. Joseph Hospital and Children's Hospital identified nine children in Whatcom County who were diagnosed with ALL after 1990 and were 15 years of age or younger at the time of their diagnosis. Our initial case definition included children with ALL from all of Whatcom County in case those children who currently lived outside the zip codes of interest had lived within those zip codes prior to diagnosis. A social worker from HHS conducted interviews from April through June 1998. The interview form included both known and possible causes of ALL and issues about which the community was concerned. The questionnaires were sent by certified overnight mail to DOH for analysis.

Findings

We interviewed the families of six of the nine children identified with ALL. Only five of the children had lived in the zip codes of interest. The ages at which the children were diagnosed were consistent with national patterns. The race and ethnicity of the children were similar to those of all children in the area. Nearly equal numbers of boys and girls were affected.

None of the respondents reported exposure to radiation therapy. Only one child had x-rays before diagnosis and another reported use of home or folk medicines. The parents of only one of the children lived in the zip codes of interest prior to the child's birth. Therefore, *in utero* exposures that occurred locally could not have been a factor. None of the children lived in crowded living conditions.

Respondents indicated that two of the five children used only public water supplies while living in the zip codes of interest. The other three children used a combination of public water supplies and private well water. None of the public water supplies had detectable levels of EDB or 1,2 DCP, indicating that the children were not exposed to these contaminants from public drinking water supplies.

Historic information on water quality is not available for the three private wells. However, wells in close proximity to those used by the children have been tested and found to be free of EDB and have levels of 1,2 DCP considerably below the maximum allowable level. Data from testing of selected wells in Whatcom County indicate that EDB and 1,2 DCP take at least seven years to disappear from affected wells. Based on this information and the dates the children used the well water, at least two children of the three children who used private well water were most likely not exposed to EDB. One of the two children may have been exposed to 1,2, DCP. If so, the level of 1,2, DCP was most likely below the standard set by EPA for drinking water.

Testing results in combination with the diversity of water supplies and sources argue against exposure to EDB and 1,2 DCP in drinking water as the cause for the cluster of ALL.

Four of the five children who participated in the survey lived near farming and had potential exposure to pesticides, either through proximity to farming or residential use of pesticides. However, these potential exposures may not be rare events for this geographic location. Additionally several recent reviews suggest that parental occupational exposure to pesticides and home use of pesticides may be more important in the development of ALL than living in an agricultural area. Parents of only one child reported use of pesticides in the home and none of the parents were involved in agricultural work, suggesting that these two types of potential exposure to pesticides are not a factor in this cluster of ALL. Additional study of the relationship of potential pesticide exposure to the development of childhood ALL is best conducted as a multi-site study enrolling, for example, children with leukemia from many areas across the United States.

The diversity of employers and occupations makes a common parental occupational exposure unlikely for this group of children. There was no evidence that the children had common exposures related to attendance at the same childcare centers or schools, community or recreational activities, or outdoor play areas.

Parents did not report potentially problematic dietary patterns. We did not find anything unusual about the mothers' pregnancies. There were no patterns of

cancer among family or household members. Rates of smoking among parents in this survey are consistent with rates for all of Washington. No one reported birth defects or other genetic conditions known to be associated with childhood ALL. Intermarriage, potential exposure to benzene, and taking medications known to be associated with the development of ALL were not identified by respondents in this survey.

Conclusions and Recommendations

Although case series studies have limitations, the survey rules out some of the community's concerns about a common exposure. In particular, the concern that exposure to EDB and 1,2 DCP in drinking water may be related to the development of ALL does not seem to be substantiated as a factor common to the children with ALL. The lack of shared factors among these five children, however, does not eliminate any of these causal factors for an individual child.

There is historical interest in leukemia clusters. Several investigations show evidence that ALL clusters geographically, but scientists do not have an explanation for this phenomenon. One explanation is that cancer clusters are random in space and time. This may be due to a random clustering of individual risk factors. This cluster of cases in Whatcom County between 1992 and 1994 may well have been a random cluster. Concern for potential on-going common exposures is lessened by the findings that the rates of childhood ALL are not elevated in the 1993 through1995 and 1994 through 1996 time periods.

We do not know why there were more cases of childhood leukemia than expected in the zip codes of interest between 1992 and 1994. Most children with leukemia do not have any known risk factors and the cause of their cancer remains unknown. Although many adult cancers can be prevented by lifestyle changes, there is currently no known way to prevent most childhood cancers, including most ALL. However, there are several public health recommendations related to findings in this survey that are helpful in lowering overall rates of cancer and other adverse health outcomes:

- DOH and HHS support the use of residential and commercial integrated pest management to reduce the potential for pesticide exposures.
- DOH and HHS recommend that owners of private wells routinely test their drinking water. Wells should be tested for coliform bacteria each year. Nitrates testing should be done at least once every three years. If nitrates are found in the water, testing should be repeated yearly to determine if the levels are changing. A pesticide analysis may be warranted every three to four years if the well is located near a known pesticide-contaminated area. If a well is found to contain levels of contamination above the maximum allowed level, a different source of water should be used or the water should be treated prior to use and the well should be tested annually. If low levels of contaminants that do not prevent the water from being used are present, the well should be monitored at approximately six-month intervals to establish the pattern of contamination during fluctuating water levels. HHS can assist with individual water-testing decisions.

- DOH and HHS support the recommendations of the National Cancer Institute to eat a healthy diet that includes least five servings of fruit and vegetables per day. This dietary habit may help protect children and adults from developing several types of cancer.
- DOH and HHS recognize the health risks of smoking in general, smoking during early pregnancy, and environmental tobacco smoke exposure. Therefore, we strongly urge all persons to stop smoking.

We do not recommend surveying a control series for the following reasons:

- We did not find unique patterns of exposure suggesting the need for further investigation in Whatcom County. Other than potential exposure to pesticides and farming, the children did not seem to share common factors.
- While the number of children with leukemia may be high for a small area, the number is too small to allow us to rule out factors with certainty. Finding no difference between cases and controls could be because there is really no difference or because the numbers are too small to allow us to detect subtle differences.
- Given the recent information from the cancer registry indicating no new cases in the selected zip codes of childhood ALL in 1995 and one new case in 1996, we are less concerned than previously about a potential on-going exposure in Whatcom County related to the development of childhood ALL.

To gain additional evidence for our judgements related to water quality, HHS tested two of the three private wells used by the three children. HHS was unable to obtain consent to test the third well. Results of these tests showed no contamination with synthetic or volatile organic compounds, including EBD; 1,2, DCP; and DBCP. Details of this testing are available though HHS.

DOH will continue to monitor the number of cases of ALL in the area using WSCR data. DOH and HHS will continue to work on identifying, decreasing and eliminating contamination of groundwater in Whatcom County.

BACKGROUND

This section is intended to provide a brief overview of leukemia and introduce the concepts and language of study methods.

Leukemia. Leukemia is a malignant disease (cancer) of the bone marrow and blood, characterized by the uncontrolled growth of specific types of white blood cells. While leukemia occurs about 10 times more often in adults than in children, it is the leading cause of childhood cancer. Leukemia can be either acute (rapidly progressing), or chronic (slowly progressing). Acute lymphocytic leukemia (ALL) is the most common type of leukemia that occurs in children under age 15. Overall, about 42% of people diagnosed with leukemia live for at least five years after diagnosis. Approximately 80% of children diagnosed with ALL live for at least five years after diagnosis.

ALL occurs most often in the first decade of life but increases in frequency again in older individuals. Unlike other forms of leukemia, ALL occurs at different rates in different geographic locations. There are higher leukemia rates in more developed countries and in higher socioeconomic groups. In most cases, the cause of ALL is not evident and few factors have been associated with an increased risk of developing the disease. Leukemia can cluster in families, suggesting a genetic component or common exposures. Certain genetic diseases that cause children to be born with an abnormal or deficient immune system, such as Li-Fraumeni syndrome, Down's syndrome, and Kleinfelter's syndrome, place a child at increased risk to develop ALL. Chronic exposure to benzene in the workplace and exposure to high doses of ionizing radiation can cause leukemia. Patients who receive immunosuppressive therapy (such as organ transplant patients) are at increased risk of developing ALL. While benzene exposure has been linked to adult forms of another type of leukemia (acute monocytic leukemia), ALL in children has not been conclusively linked to any cancer-causing chemicals. Factors such as exposure to pesticides; maternal use of alcohol, cigarettes, or contraceptives; paternal occupational exposure to chemicals and solvents; and chemical contamination of ground water have been suggested as risk factors for ALL, but these factors have not been definitively linked to ALL.

Study Methods. Public health officials commonly use two methods to investigate potential clusters of cancer in communities: the case series and the case-control methodologies. The case series method obtains information about people with the disease (cases) and looks for common patterns that might suggest a potential cause of the disease. It cannot provide definitive answers, because generally, it cannot distinguish between factors unique to the cases and factors to which the whole community may be exposed.

In case-control methodology, cases (people with the disease) are compared to controls (people who do not have the disease). Controls must have the opportunity to be exposed to the factor of interest, but they must not be so similar to the cases that they would automatically have the factor. The latter

situation is called “over-matching.” Controls are usually selected to resemble the cases for factors related to the disease, but not under investigation. For this investigation, the age and sex of the children were factors for which we would match cases and controls.

To conduct a case-control study of children with leukemia in Whatcom County, we would need to identify control children who were from the area of interest so that they would have potential exposure to environmental factors of concern. However, they could not be so closely matched that they would automatically have those factors. For example, children from the same neighborhood are likely to have the same water sources or have water sources from the same aquifer and so matching on neighborhood might result in over-matching. Matching on zip code of birth or school district might be a reasonable way to match. These areas are small enough that control children would have the opportunity for similar exposures, but large enough that they would not automatically be exposed to the factors under investigation.

Although evidence from a case-control study may be stronger than that from a case series, case-control studies also have limitations. In small studies (for example less than 100 cases and controls), it is difficult to determine whether finding no difference between cases and controls is because there really is no difference or because the sample size is too small to find the difference. The smaller the cause-effect relationship, the larger the numbers need to be.

A number of other factors may also affect the findings from case-control studies. For example, parents of children who have a disease are often more sensitive to potential exposures, and thus, report those exposures more completely, than parents whose children are not sick. This tendency can make it difficult to interpret findings from case-control studies. Additionally, our confidence in the results from case-control or other types of epidemiologic studies comes from finding similar conclusions in a wide variety of studies that all address the same issue. One study is usually not definitive.

INTRODUCTION

In November 1997, a parent of a child with ALL from Whatcom County contacted the Washington State Department of Health (DOH) Office of Epidemiology. The parent was concerned about the number of children with leukemia in areas of north and west Whatcom County. This concern was related to issues of water quality. Since the mid-1980s, wells in the area were known to be contaminated with ethylene dibromide (EDB) and 1,2, dichloropropane (1,2 DCP).
The parent requested an analysis of the Washington State Cancer Registry (WSCR) to determine whether there were more children with leukemia in these areas than in other parts of Washington State.

Since 1992, health care providers and laboratories have been required to report new cases of cancer in Washington state residents to DOH. DOH compiles these reports into WSCR. Information in WSCR relevant to an analysis of

leukemia in selected zip codes in Whatcom County includes address and age at diagnosis, date of diagnosis and type of cancer. At the time of the request, WSCR data were available for 1992 through 1994. DOH reviewed the WSCR data for all children under age 20 with ALL who lived in Custer (98240), Everson (98247), Ferndale (98248), Lynden (98264) and Sumas (98295) at time of diagnosis.

This analysis showed that the number of children with ALL in this geographic area was statistically significantly greater than expected when compared to Washington as a whole ($p < .05$). In particular, the number of children less than five years old diagnosed with ALL during the 1992-1994 period was statistically significantly greater than expected (see table below). A review of data from the Comprehensive Hospital Abstracting and Reporting System (hospital discharge) for 1987 through1996 gave similar results. (See Attachment 1 for methods and additional detail).

Washington State Cancer Registry Leukemia Incidence Data
Custer (98240), Everson (98247), Ferndale (98248), Lynden (98264) and Sumas (98295)

	1992-1994		1993 – 1995		1994 - 1996	
Age	Observed*	Expected*	Observed	Expected	Observed	Expected
0 – 4	5**	0.9	3	0.9	3	1.0
5 – 9	0	0.4	0	0.4	1	0.4
10 – 14	1	0.3	1	0.3	0	0.2
15 – 19	0	0.2	0	0.2	0	0.3
Total	6**	1.7	4	1.8	4	2.0

* Observed cases are the number of new reports to the Washington State Cancer Registry for the time period indicated. Expected cases are the number expected if the rates in the selected zip codes are the same as those in Washington state. Population data used in calculating the expected number of cases are the Washington State Adjusted Population Estimates from the Department of Social and Health Services, Research and Data Analysis. These estimates are based on estimates by Claritas Inc. and Office of Financial Management, June 30 , 1997.

****** Statistically significantly elevated at $p< 0.05$, i.e. if there is really no difference between the observed and expected, we would expect this result to occur by chance less than 5 out of 100 times.

Subsequent to the survey, WSCR data for 1995 and 1996 became available. No additional children with ALL from the zip codes of interest who were less than 20 years old at time of diagnosis were reported to WSCR in 1995. One child was reported to WSCR in 1996. The observed numbers of cases of childhood ALL for the 1993 through 1995 and 1994 through 1996 time periods are not statistically significantly different from expected. The later rates are not significantly elevated because the cases from the 1992 through 1994 time period accounted for all but one of the cases observed in the later time periods.

Based on the findings for the 1992 through 1994 time period, DOH provided assistance to Whatcom County Health and Human Services Department (HHS) in conducting a survey to determine whether children in this area had factors in common that might be related to the onset of ALL.

METHODS

Given the limitations of both case series and case-control studies, we concluded the best approach was to interview the parents of children with leukemia (case series). Based on the information obtained from the interviews, we would determine the usefulness and feasibility of interviewing controls.

The analysis described above focused on children diagnosed with ALL while living in Custer (98240), Everson (98247), Ferndale (98248), Lynden (98264) or Sumas (98295). In an effort to include all children with ALL in the survey, HHS recommended including all children diagnosed with ALL in 1990 or later and who were under 15 years old at the time of diagnosis. The area of interest included the five zip codes listed above and rural Bellingham (98226). We included rural Bellingham because HHS thought that exposures for residents of this zip code might be similar to those in the other five rural zip codes.

We recognized that families might have moved from the zip codes of interest to other areas of the county before their child's diagnosis. To increase the likelihood of identifying these families, HHS worked with community members, staff at DOH, and the medical records personnel at St. Joseph Hospital and Children's Hospital to identify all children who were diagnosed with ALL after 1990 and were 15 years of age or younger and living in Whatcom County at the time of their diagnosis.

We did not include children diagnosed prior to 1990 because we were concerned about our ability to obtain accurate information about events that occurred more than ten years in the past. Although the causes of adult and childhood ALL are believed to vary, there is no definitive age to divide these two groups. We limited the age to 15 years because these are more likely to be the childhood form of ALL and as age at diagnosis increases, parents would be asked to recall events further in the past.

DOH revised a questionnaire used for a similar survey in Yakima county in 1996. This questionnaire was developed with assistance from the federal Centers for Disease Control and Prevention and health care providers in that community. The questionnaire covered both known or suspected causes of ALL and issues about which the community was concerned. Revisions for the Whatcom questionnaire were based on experience gained from using the Yakima questionnaire and on input from HHS, community health care providers, and an outside expert identified by community members. A copy of the questionnaire is included as Attachment 2. Interviews with the families of children with ALL were conducted by a social worker from HHS during April, May, and June 1998. For confidentiality purposes, completed questionnaires were sent by certified overnight mail to DOH, where responses were entered into a Microsoft Access® database. Access® software was used to tabulate the responses.

RESULTS AND DISCUSSION

We identified nine children who were diagnosed with ALL after 1990 and who were 15 years old or younger and living in Whatcom County at the time of

diagnosis. Families of six of the nine children with ALL participated in the survey. Four interviews were conducted with the child's mother and two were conducted with the child's father and mother both present. Three families could not be located or contacted at the time of the interviews or declined participating in the survey. For information about children who did not participate, see Study Limitations on page 23 of this document.

The results of the survey and a discussion of those results follow. Section titles refer to the corresponding section of the questionnaire used for the survey. In 1996, Schottenfeld and Fraumeni edited *Cancer Epidemiology and Prevention, Second Edition* (New York, Oxford University Press). Based on the relatively recent publication date, the quantity of material reviewed, and the expertise of the chapter authors, we have relied on this publication for relevant background material presented in the discussion sections. Information relevant to this report is available in two chapters: Chapter 40, The Leukemias, and Chapter 61, Cancers in Children. A copy of this book is available at HHS. Other sources of information used in this report are footnoted.

Sections II and III: Demographic and Diagnosis Information

Results. The six children with ALL for whom we conducted interviews were born between 1985 and 1992 (Table 1). One child was diagnosed with ALL in 1991, one in 1992, one in 1994, two in 1996[1], and one in 1997. The average age at diagnosis was five years (63.7 months), with a range of two to nine years (27 to 113 months). Three children were diagnosed between two and four years old. Two children were diagnosed close to their sixth birthday and one child was diagnosed at age nine. Four children are male and two are female. All six children are white, non-Hispanic. Different physicians diagnosed each of the six children.

Table 1: Demographics

Proportion Female	Proportion White	Proportion Hispanic	Average Age at Diagnosis
2/6	6/6	0/6	5 years (63.7 months)

Discussion. Children with ALL are most often diagnosed between two and four years of age, but rates among children ages five and six are similar to rates among two-year olds. Three of the six children were diagnosed between ages two and four and two were diagnosed at age six. This age distribution is not unusual. National rates of leukemia are slightly higher for boys than girls (1.1 - 1.4 boys are diagnosed for each girl diagnosed). The distribution of sexes within the surveyed group is not significantly different from expected. All of the children are white and non-Hispanic. According to population estimates released by the Washington State Department of Social and Health Services for 1997, over 90% of the children less than 15 years old in Whatcom County were white and less than 7% were of Hispanic ethnicity. Therefore, the race and ethnicity of the children with leukemia is similar to that of all children in Whatcom County.

[1] Only one of these children lived in the zip codes of interest; see page 11.

Section IV: Medical History

Results. Only one of the children reported use of home/folk remedies (homeopathic teething tablets) for at least one month between birth and diagnosis. Five children did not report radiation therapy prior to diagnosis. This information was unknown for one child. One child received x-rays prior to diagnosis, four did not. This information was unknown for one child.

Discussion. Radiation therapy has been associated with increased risk of developing leukemia. However, radiation therapy prior to diagnosis was not reported for any of the children in this survey. Only one child was reported as having been exposed to x-rays and one was exposed to homeopathic remedies. Therefore, radiation therapy, use of non-traditional medicines and exposure to x-rays before diagnosis are not common factors for the six children in this survey.

Section V: Residential History and Potential Environmental Exposures Related to Residence

Residence

Results. We focused on the residence of the child up to the time of diagnosis, the residence of the mother for one year prior to pregnancy and during pregnancy, and the residence of the father for one year prior to conception.

Table 2 shows the total number of residences for each child and their distribution over the time periods of interest. Each letter represents a unique address for the residence of the parents and/or the child. For example, for the second child, in the year before conception, the father and mother both lived at address A. The mother continued to live at address A during pregnancy. The family moved to address B when the child was born. The child lived at addresses B, C, and D prior to diagnosis. Address letters that are italicized with strikethrough (~~*X*~~) indicate they were not in Washington. Those in parenthesis (X) indicate the person resided at this address less than six months. Address letters that are bold (**X**) are within the zip codes of interest specified above. Those that are underlined (X) are in Whatcom County, but not the zip codes of interest. The far right column of the table gives the zip code for each bolded address.

Table 2: Residence History

ID	Prior to Conception Father	Prior to Conception Mother	Pregnancy Mother	Birth to Diagnosis Child	Zip codes for Addresses in Area of Interest (by letter)
1	**A**	**A**	**A**	**A**	**A** (98264)
2	~~*A*~~	~~*A*~~	~~*A*~~	~~*B C*~~ **D**	**D** (98264)
3	~~*A*~~	~~*A*~~	~~*A B*~~	~~*B*~~ **C D**	**C** (98226) **D** (98240)
4	A	A	A	A B C D E (F)	
5	~~*A*~~	~~*A*~~	~~*A*~~	~~*A B C D*~~ (E) **F**	**F** (98226)
6	~~*A*~~	~~*A*~~	~~*A B*~~	~~*B C D*~~ E **F G H**	**F** (98247) **G** (98248) **H** (98264)

X indicates the address for this residence was in the area of interest.
~~*X*~~ indicates a residence was out of state
(X) indicates the person resided at this address less than six months
X indicates the address for this residence was in Whatcom County but not in the area of interest.

The six children lived in 26 residences, 24 of which were occupied for more than 6 months. Only one child's parents (child 1) lived in the area of interest prior to conception or during pregnancy. Four of the six children (children 2, 3, 5, 6) were conceived and born out of state and lived in at least one residence out of state prior to moving to Washington. Three of the six children lived in two or more out-of-state residences prior to living in Washington.

One child (child 4) and the child's parents did not live in any of the zip codes targeted in this survey prior to the child's conception through diagnosis. This child moved to Whatcom County four months prior to diagnosis (residence F). Since this child never lived in the zip codes targeted in this survey, the information for this child was excluded from further analysis. This child was diagnosed in 1996 but was not counted in the analysis of the WSCR leukemia incidence data for 1994 through 1996 (see table in Introduction section) since the family had never lived in the zip codes of interest. Four of the remaining five children moved to Whatcom County after birth.

The goal of the survey was to identify potential common exposures in Custer (98240), Everson (98247), Ferndale (98248), Lynden (98264), Sumas (98295), and rural Bellingham (98226) that may lead to the development of ALL. Therefore, we focused the remainder of the analysis on the exposures of the five children from birth through diagnosis (child 1) or from the time the child moved to the county through diagnosis (children 2, 3, 5, 6).

Discussion. The residences of the parents in the year prior to conception and the mothers during pregnancy were highly diverse and primarily out of state. This makes a common parental exposure prior to conception or *in utero* exposure of the child related to a particular water system, aquifer, or other local hazardous site unlikely. A recent study[2] of children with ALL diagnosed through age three describes work in which "cells carrying the mutation found in the

[2] Gale KB, Ford AM, Repp R, Borhardt A, Keller C, Eden OB, and Greaves ML. Backtracking leukemia to birth: identification of clonotypic gene fusion sequences in neonatal blood spots. Proceedings of the National Academy of Science, Vol 94, pp 13950-54, 1997.

children's leukaemic cells were present at birth." This suggests that ALL in children under three years of age may result from *in utero* exposures. It is not clear whether these findings apply to older children.

A study examining exposure to drinking water contaminated with several organic compounds (trichloroethylene, perchloro-ethylene, chloroform, and other organic compounds) found that the odds of developing ALL were highest for children who were exposed to the water *in utero*[3]. For five of the six children in this study, there were no *in utero* exposures associated with living in Whatcom County.

Five of the six children lived in the specified zip codes for at least 6 months before diagnosis. Since the children lived in a diversity of zip codes, the possibility of a common exposure from a localized activity is not highly likely. This does not rule out a common exposure to a carcinogen or other risk factor that is found in multiple geographic locations.

Crowding

Results. For the 20 residences the children lived in after birth, all five children lived in homes with occupancy rates of one or fewer persons per room.

Discussion. Childhood ALL has been associated with non-specific childhood viral and/or bacterial infections. These infections may spread more easily in crowded living conditions, whether directly due to crowding or to factors associated with crowding. Studies in the United States and Canada usually define crowding as more than one person per room. Using this criterion, none of the children lived in crowded conditions.

Water Quality

Results. Table 3 shows the source of water for drinking (D), cooking (C), bathing (B), and formula mixing (F), by residence, for each child while residing in the zip codes of interest. Separate columns indicate the type of water system (public or private) and where the water for the system originated (surface or well). Water-testing information focusing on the results for chemicals of special concern to the community and the source of the water-testing information are also presented.

Chart 1 also illustrates each child's exposure to the three types of water: private well water, public water drawn from a well, or public water drawn from a surface source, such as Lake Whatcom or the Nooksack River, in relation to the date of diagnosis.

Respondents indicated that two of the five children used only public water supplies for drinking, bathing, cooking, or formula preparation while living in the

[3] Woburn Childhood Leukemia Follow-Up Study, Information Booklet, 1996. Massachusetts Department of Public Health. February 1999. <http://www.state.ma.us/dph/beha/leukfact.htm

Table 3: Water Source, Water Usage and Testing Results with a Focus on EDB, DBCP and 1,2, DCP
(Additional detail on testing dates and results is included in the text.)

ID	Residence	System Type	Source of Water	Water Use	Testing Information	Source of Information
1	A (until 5/92)	Private	Well	D C B	High levels of unknown substances.	Family interview
	A (after 5/92)	Public	Nooksack River	D C B	In compliance with monitoring plan. Monitored annually since 1988 for IOC, VOC, and SOC. EDB and DBCP tested in 1992. EDB, DBCP and 1,2, DCP were not detected.	City of Lynden Washington State DOH
2	D	Public	Well	D C B	1982 to 1998: Nitrate levels exceeded the MCL of 10 ppm. 1981 and 1987: Manganese levels exceeded the MCL. 1994 and 1998: VOCs, SOCs, EDB and 1,2 DCP tested. EDB, DBCP and 1,2, DCP were not detected.	HHS Water System Files
3	C	Public	Lake Whatcom	D C B F	In compliance with monitoring plan. Monitored annually since 1988 for IOC, VOC, and SOC. EDB tested in 1993 and DBCP tested in 1994. EDB, DBCP and 1,2, DCP were not detected.	City of Bellingham Washington State DOH
	D	Private	Well	D C B F	1989: Nitrates = 3, positive for coliforms prior to sealing well. Later results were negative.	Family interview. No records in HHS files. Files retained for two years at time of test.
5	F	Public	Lake Whatcom	D C B	In compliance with monitoring plan. Monitored annually since 1988 for IOC, VOC and SOC. EDB tested in 1993 and DBCP tested in 1994. EDB, DBCP and 1,2, DCP were not detected.	City of Bellingham Washington State DOH
6	F	Private	Well	D C B	No testing information available	Family interview
	G	Public	Nooksack River	D C B	In compliance with monitoring plan. Monitored annually for IOC, VOC, and SOC. EDB and DBCP tested in 1998. EDB, DBCP and 1,2, DCP were not detected.	City of Ferndale Washington State DOH
	H	Public	Nooksack River	D C B	In compliance with monitoring plan. Monitored annually for IOC, VOC, and SOC. EDB and DBCP tested. EDB, DBCP and 1,2, DCP were not detected.	City of Lynden Washington State DOH

Water use notation: D = drinking water supply; C = cooking water supply; B = bathing water supply; F = formula water supply

Definitions: for a complete list of chemicals included in each class, see Attachment 3.

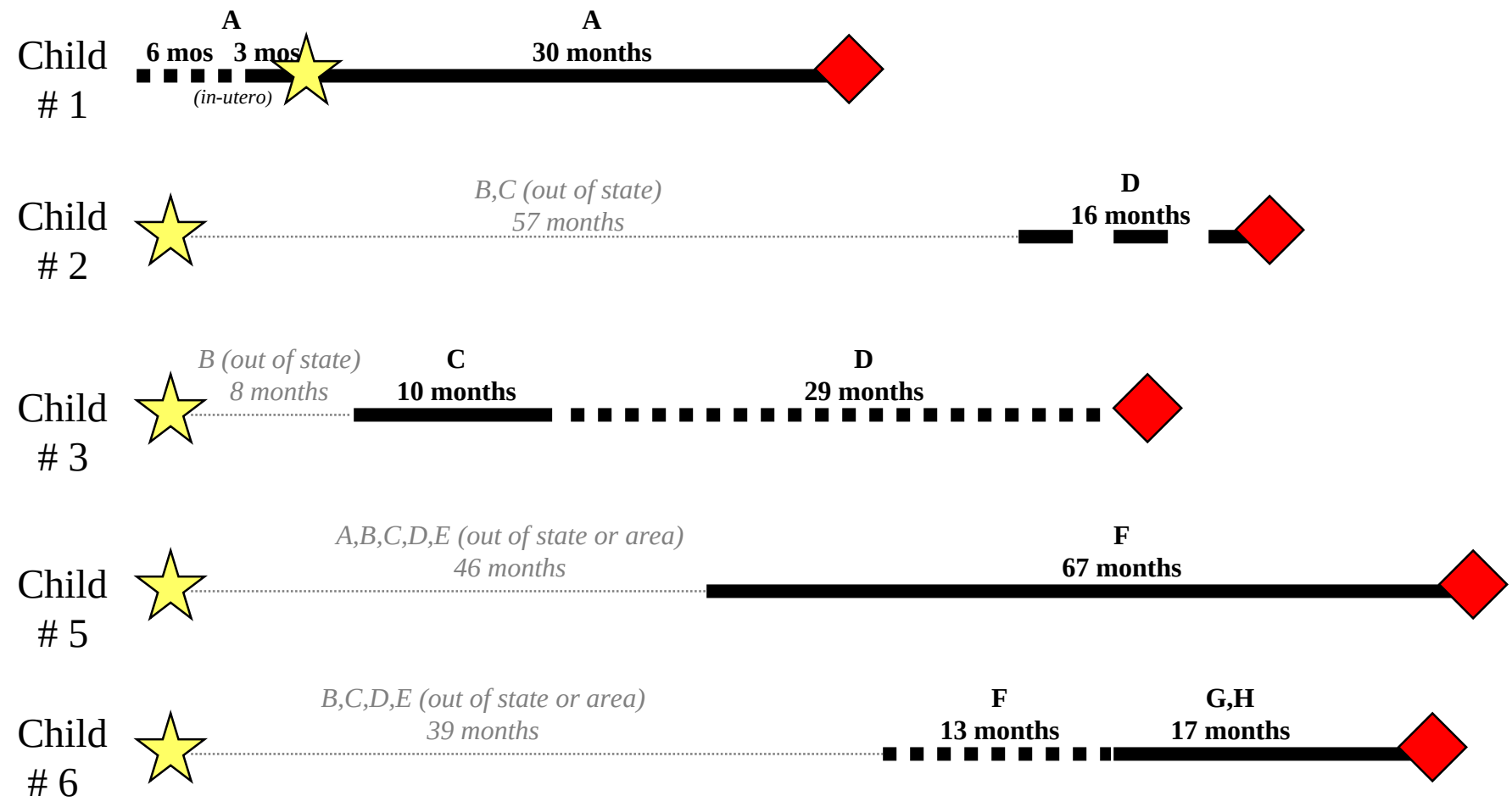
IOC = inorganic chemicals
VOC = volatile organic chemicals (including 1,2, DCP)
SOC = synthetic organic chemicals

1,2 DCP = 1,2 dichloropropane
DBCP = dibromochloropropane
EDB = ethylene dibromide

MCL = maximum contaminant level
ppm = parts per million

Note: Drinking water utilities using surface water (i.e. Nooksack River, Lake Whatcom) are not required to routinely test for EDB and DBCP. These compounds escape into the air rapidly and are rarely detected in surface water even before the water is treated for distribution to residents.

Chart 1. Water Exposure (by Residence) for Children Participating in Whatcom County ALL Survey



which was 41 months after the child began using the water. This public source is monitored annually for IOCs, VOCs (which includes 1,2 DCP) and SOCs. No compounds except iron have been detected at levels exceeding the maximum allowable amount. Iron was found at 1.13 parts per million (ppm) in 1989 and the maximum allowable level is 0.3 ppm. For child 3, the public water was tested approximately three years after the child began using the water and EDB, DBCP and 1,2, DCP were not detected.

Since EDB, DBCP, and 1,2, DCP rapidly disappear from surface water, the findings related to these chemicals in the public water systems used by children 1,3 and 6 are not surprising and indicate that these children were not exposed to EDB, DBCP, or 1,2, DCP from public water supplies. Other SOCs and VOCs have occasionally been detected in these public supplies, but these compounds are not found consistently and not above the maximum allowable amount with the exception of trihalomethanes. Trihalomethanes, which are VOCs, are a by-product of chlorination and are found well below the maximum allowable level in these water supplies. Thallium, iron and mercury (IOCs) have each been detected one time since 1988 at levels higher than the maximum allowable level for the city of Bellingham.

Historic information on water quality is not available for the three private wells for children 1, 3 and 6. However, there is some information on EDB and 1,2 DCP contamination from wells in the area, some of which are in close proximity to those used by the children. This information indicates that while in some instances there were different findings for adjacent wells, contaminated wells tended to cluster in defined areas. All three children began using private well water approximately 2.5 years before their diagnosis.

For one child, three wells within 0.25 to 0.5 mile were tested approximately one year after the child stopped using the water. None of these wells had detectable levels of EDB or 1,2, DCP. On repeat testing of two of these wells in 1998, one showed no detectable levels of EDB and 1,2, DCP. The other showed no EDB, but 1,2 DCP at 0.25 parts per billion (ppb or micrograms per liter). The maximum allowable level is 5.0 ppb. Although the lowest detectable level of 1,2 DCP varies with the testing method used, this level is well below the maximum allowable level, which does not change. Based on these findings, it is likely that this child was not exposed to EDB through private well water. While the child may have been exposed to 1,2, DCP, the level of 1,2, DCP in the water of the nearby well was below the standard set by EPA for drinking water.

Wells within 0.25 to 0.75 miles of the private wells of the other two children were tested approximately five and nine years after the children began using the water. EDB and 1,2 DCP were not detected. Based on current data indicating that all wells in the area with detectable levels EDB and 1,2 DCP in 1991 still had detectable levels in 1998, the well of the child tested five years after the child began using the water was most likely free of EDB and 1,2 DCP when the child used the water. Using this information, we cannot speculate whether the water source tested nine years after the child's use was contaminated.

Discussion. Water testing information relative to dates of water use for the public water supplies indicates that chemical exposures to IOCs, VOCs and SOCs through public water supplies are not a common factor among the five children. Based on the following findings, in our judgement exposure to EDB and 1,2 DCP is not likely to be a common factor related to the development of ALL in these children.

- The public water supplies have been tested and found to be free of EDB and 1,2 DCP.
- Wells within 0.25 to 0.75 mile of the private wells have been tested and found to be free of EDB and have levels of 1,2 DCP considerably below the maximum allowable level.
- Comparative data indicate that EDB and 1,2 DCP take at least seven years to disappear from affected wells in this area. Therefore, at least two children who used private well water were most likely not exposed to water contaminated with EDB. One child may have been exposed to very low levels of 1,2, DCP.

Potential Pesticide Exposure

Results. Table 4 illustrates the residences for the children whose parents reported residential use of pesticides and potential exposure to pesticides through aerial spraying while living in the zip codes of interest. The residence letters correspond to those in Table 2. Respondents for four of the five children reported proximity to pesticides. Of the two respondents who reported aerial spraying, one respondent indicated the aerial spraying was on raspberry fields. Therefore, the spraying could have been insecticides and/or herbicides. The other respondent did not know the purpose of the aerial spraying. Commercial lawn care may involve insecticides or herbicides.

Table 4. Residences* Where Potential Pesticide Exposures Were Reported

	Insecticides		Rat Poison		Weed Killer		Lawn Care	Bug Repellent	Aerial Spray
ID	In	Out	In	Out	In	Out			
1	A					A			A
2									
3									D
5						F		F	
6		F					H		

*Residences in the zip codes of interest from the child's birth to diagnosis are included in this table. See Table 2 for detailed residence history. In = inside the home; Out = outside of the home.

Discussion. As reviewed by Daniels et al.[4], a growing number of scientific studies are suggesting a link between childhood ALL and post-natal exposure to studies are suggesting a link between childhood ALL and post-natal exposure to pesticides in the home, particularly the use of no-pest strips and frequent

[4] J. L. Daniels, A. F. Olshan, and D. A. Savitz. Pesticides and Childhood Cancers. 1997. Environmental Health Perspectives, v. 105(10):1068-1077.

exposure to pesticide use in the home. The same review notes that living on a farm, garden pesticide use and home extermination do not seem to increase risk for ALL. Although four of the five children had potential exposure to herbicides and insecticides, we cannot evaluate whether exposures actually occurred, and if so, whether the exposures were the same for the four children. Additionally, parents of only one child reported indoor use of pesticides. Therefore, exposure to household pesticides is not a common factor among the children.

Proximity to Industry and Farming

Results. Table 5 illustrates the proximity of residences of the children to industrial settings. Again, we focused on the residences in the zip codes of interest for each child from birth through diagnosis. The residence letters in Table 5 are the same as in Table 2. Respondents reported that all of the children lived in one residence prior to diagnosis that was less than one-half mile from industrial or agricultural activity. Four of the children were reported to have lived in close proximity to agricultural areas with berry production reported near three residences. The distances between the residence and the commercial interest were not verified for accuracy.

Table 5. Proximity of Industry to the Residence of Child Prior to Diagnosis

ID	Nearby Industry (by Residence Letter)	Distance From Residence to Industry
1	A. Private farm (corn)	Less than 0.25 mile
2	D. Dairy farm	Less than 0.25 mile
	Raspberry farm	Less than 0.25 mile
	Strawberry farm	Less than 0.25 mile
3	D. Strawberry & potato fields	Less than 0.25 mile
	Home & well on former strawberry field	Not applicable
	Tree farm	Less than 0.25 mile
5	F. Light industry (aircraft components)	0.5 mile
6	F. Raspberries; general farming	0.5 mile

Discussion. Schottenfeld and Fraumeni report that occupational agricultural exposures related to livestock production, certain crop production (corn, soybeans, other cereal grains), various agricultural chemicals (pesticides, herbicides, fertilizers), and viruses have been associated with elevated leukemia risk for adults. However, it is important to remember that occupational exposures are often higher than exposures to the community surrounding the industry. Schottenfeld and Fraumeni do not report studies of children living near farms. Daniels et al. (op.cit.) note that children living on farms are not at increased risk of developing leukemia. While respondents for four of the children reported proximity to commercial agricultural activities with berry production reported near three residences, based on the scientific literature, it is difficult to evaluate the significance of this finding. Additionally, according to HHS staff, the area of interest is primarily agricultural, including dairy, potato, and berry farms. Although having interviews for only five children and not having a control group contribute to the difficulty in interpreting this finding, four out of

five children living near farms may not be unusual for this geographic area. (See Limitations Section.)

Section VI: Parental Occupation and Employment

Employers and Occupation

Results. Except for self-employment, there were no reports of the same employer for the parents of the five children in the year before conception, during pregnancy, or after birth. Both parents of two individual children were self-employed in the same business prior to conception of the affected child. The businesses and occupations for the two sets of parents were different.

Occupations reported for the parents in the year before conception, during pregnancy, or after birth were highly varied, with no single occupation reported more than once except for the two sets of parents who were self-employed in the same business with the same occupation. None of the parents were involved in agricultural work in the year before conception, during pregnancy, or after birth.

Discussion. Although a number of occupational exposures and occupations have been associated with some types of adult leukemia, Schottenfeld and Fraumeni report that information about the association of parental occupation to childhood leukemia is inconclusive. However, more recent reviews suggest that maternal occupational exposure to pesticides during pregnancy, paternal occupational exposure during the prenatal period, and parental occupational exposure after a child's birth may increase the risk of ALL[4,5]. For this group of children, none of the parents reported working in agriculture, the nuclear industry, positions that would result in exposure to non-ionizing electromagnetic fields or benzene, or other occupations reported to have an association with adult ALL. The diversity of employers and occupations makes a common occupational exposure unlikely for the parents of this group of children.

Sections VII-X: Child Care History, School Attendance, Community Activities, and Outdoor Play/Recreational Areas

Results. No parent reported that his or her child received childcare out of the home. Parents reported that five children who lived in the zip codes of interest attended eight different preschools prior to diagnosis. Four of the children attended different elementary schools before diagnosis. Parents of only one child reported participation for a period of at least six months in community activities prior to diagnosis. This activity took place in the city of Bellingham.

Outdoor play areas were those around the home. The proximity of the play areas to factories and farms, the types of industry, and crops produced were similar to those reported in the residential section. There were no new potential exposures related to outdoor play. No mothers reported swimming in potentially

[5] S. H. Zahm and M. H. Ward. Pesticides and Childhood Cancer. 1998. Environmental Health Perspectives, vol 6(supp. 3):893-908.

polluted areas during pregnancy, but one child was reported to have swum in a potentially polluted area prior to diagnosis.

Discussion. There was no evidence that the children had common exposures related to attendance at the same schools, community or recreational activities, or common outdoor play areas. This finding does not rule out common exposures from diverse sources.

Section XI: Nutritional History

Results. Parents were asked about the children's eating habits in the year before diagnosis. Four children were reported to have consumed the recommended five or more servings of fruits and vegetables per day. The other child was reported to have consumed three servings per day. The children consumed an average of 5.5 servings of fruits and vegetables per day, with a range of 3.1 to 7.9 servings.

In the year before diagnosis, parents reported that two children did not eat hot dogs or other processed meats. These children also did not take vitamins. One child was reported to have eaten seven servings of processed meats per month, but no hot dogs. One child was reported to have eaten two hot dogs per month and 21 servings of processed meats per month and one child was reported to have eaten 24 hot dogs and 11 servings of processed meats per month. The three children who ate hot dogs and/or processed meats were also reported to have taken vitamins in the year prior to diagnosis.

Parents reported that three children ate fish or shellfish in the year before diagnosis; two children ate less than one serving per week and one child ate two servings per week. The fish were from various regions, including Alaska, the Puget Sound region, and Bellingham Bay. None of the parents reported that the children had consumed raw milk or that their preferred brand of milk was a brand that was exclusively locally produced.

Discussion. Four of the five children were reported to consume at least five servings of fruit and vegetables per day; the other child ate three servings per day. Although the recommendation to eat at least five servings of fruit and vegetables per day protects against many types of cancer, consumption of fruit and vegetables has not been shown to be protective against leukemia.

Schottenfeld and Fraumeni report two studies that looked at the relationship between childhood leukemia and the consumption of processed meats. One study noted increased risk for ALL with consumption of 12 or more hot dogs per month compared to children who ate none. Only one child in this survey ate more that 12 hot dogs per month. The other study found associations between ALL and the consumption of hot dogs and lunch meats one or more times per week only among children who did not take vitamins. The three children who were reported to eat hot dogs and lunch meat were also reported to take vitamins in the year prior to diagnosis. It is unlikely that consumption of processed meat and hot dogs is a factor in the development of ALL in this group of children.

Although consumption of fish and shellfish is not a risk factor for ALL, there was community concern about eating locally caught fish that might contain contaminants. Of the three children who were reported to have eaten fish or shellfish, only one child was reported to eat fish or shellfish more than once a week in the year before diagnosis. Furthermore, respondents did not report obtaining the fish and shellfish from the same local areas.

Common potential exposures to raw or locally produced milk were not reported.

Section XII: Pregnancy History and Birth Characteristics

Results. The five mothers each reported from two to four pregnancies. The 13 total pregnancies resulted in two miscarriages and 11 live births. Different mothers reported the two miscarriages and both miscarriages occurred before the pregnancy of the child who developed ALL. Ten of the live births were full-term pregnancies. This information was not available for one of the live births. Data for number of months pregnant was also not available for one of the miscarriages. The other miscarriage was at three months gestation. All 11 children born alive, including the children with ALL, were reported as alive and healthy at the time of interview.

Of the children who developed ALL, one was first-born, three were second-born, and one was third-born. Two children weighed more than 4000 grams at birth. None of the affected children were born with birth defects. None of the mothers reported problems during the pregnancy of the child who developed ALL. None of the mothers reported exposure to x-rays or nitrous oxide during their pregnancies with the affected children. One mother took thyroid replacement medication during pregnancy. This medication has not been associated with development of ALL. Furthermore, the mothers did not take any common medications during pregnancy.

Four mothers were in their 20s when their child with ALL was born and one was in her early 30s. Three fathers were in their late 20s at the time of conception of the child with ALL, one was in his early 30s, and one was mid-40s. One couple reported having difficulties with conception, three reported no difficulties, and this information was not available from one interview.

Discussion. Two mothers reported miscarriages of a pregnancy prior to giving birth to the child that developed ALL. Although miscarriage has been reported in some studies to be associated with childhood leukemia, other studies have not found this association. Some, but not all, studies report that first-born children and children with a birth weight of more than 4000 grams have an increased risk of ALL. While all of the children had one of these potential risk factors (first-born, high birth weight, prior miscarriage of mother), these are only potential risk factors and most children with these factors do not develop ALL. These factors are generally not amenable to change through medical or public health interventions or through lifestyle changes.

Medication use, complications or illness before or during pregnancy, and exposure to x-rays or nitrous oxide during pregnancy do not appear to be factors in this survey.

Maternal age of 35 years or greater has been associated with increased risk of childhood leukemia. None of the women in this survey were over 35 years old when the child who developed ALL was born.

Section XIII: Familial Cancer

Results. No respondents reported cancer among parents or siblings of the children with ALL. There were also no reports of cancer among aunts, uncles, or cousins; although two respondents reported cancer among grandparents or great-grandparents. There were no commonalities among the types of cancer reported.

Discussion. Schottenfeld and Fraumeni report studies that show an excess of leukemia among siblings and parents of children with leukemia. However, there were no cases of leukemia among siblings or parents of the children in this survey.

Section XIV: Familial Birth Defects and Congenital Disorders

Results. Three respondents reported no birth defects among siblings or half-sibling of the children with ALL. One respondent reported a parent with a congenital birth defect not known to be associated with ALL. Another respondent reported a relative with diabetes that they thought was congenital. Family history of diabetes has not been associated with ALL.

Three of the respondents indicated that none of the children's relatives had a family history of Down's, Bloom's, or Fanconi's syndrome which are congenital disorders associated with an increased risk of leukemia. One mother indicated her cousin was affected with Down's syndrome. One respondent did not know this information for any of these syndromes.

Discussion. Specific birth defects, including Down's, Bloom's, and Fanconi's syndrome, have been associated with ALL. While familial clustering of both Down's syndrome and ALL has been reported, the studies do not appear to have included cousins. These are not factors explaining ALL in this group of children.

Section XV: Smoking History

Results. One child's mother reported smoking intermittently through mid-pregnancy with the affected child. Both parents of another child reported smoking: the mother smoked until pregnancy was confirmed and infrequently after the birth of the affected child; the father smoked from two years before the child was born through diagnosis. The smoking history for one respondent was not available.

Discussion. Research on maternal smoking during pregnancy and the risk of ALL has not yielded consistent findings. The same is true for research on exposure to environmental tobacco smoke. Rates of smoking among parents in this survey are consistent with smoking rates for all of Washington State.

Section XVI: Miscellaneous

Results. Parents of three children reported potential exposure to solvents (including one report of benzene) or other chemicals not usually found in the home. While we did not obtain specific descriptions of the substances, it appears that the potential exposures were different for the three children.

None of the respondents reported intermarriage between first or second degree relatives and no one reported family members having been told they had a disorder of the immune system. Four respondents indicated that neither they nor the children had taken phenylbutazone or chloramphenicol and one respondent did not know this information.

Discussion. Three of the children were reported to have potential exposures to solvents or other non-household chemicals. Studies have found an increased risk of leukemia for children whose fathers are exposed occupationally to chlorinated solvents, spray paint, dyes or pigments, methethylketone, or cutting oils. We do not know whether the children were actually exposed to any chemicals. Additionally, since it seems that the children were potentially exposed to different chemicals, the possibility of common exposures that would explain the ALL is low. Additionally, intermarriage, potential exposure to benzene, and taking medications known to be associated with the development of ALL were not identified in this survey.

SURVEY LIMITATIONS

We were only able to interview parents of six of the nine children whom we initially identified as eligible for the survey. The dates of birth and diagnosis and age at diagnosis for the three children who were not part of the survey are similar to those whose parents participated in the survey. The three children whom we were not able to interview are all boys. However, because the national rate of leukemia is slightly higher for boys, this finding is not unusual and is most likely due to the small numbers of children eligible for this survey. One of the three children had a known risk factor for ALL that is not associated with environmental exposures; one was not born in the county and is believed to have spent limited time in the county prior to diagnosis; the third child did not live in the zip codes of interest at diagnosis, but may have lived in the area of interest prior to diagnosis. Based on this information, it is unlikely that information from these children would have influenced the findings of this survey.

With interviews for only six children (only five whom lived in the area of interest) and no comparison group (i.e., interviews with families of children who have not been diagnosed with ALL), it is difficult to identify patterns of common exposures. Without a comparison group, we cannot determine if patterns we might detect are different in this group compared to the general population or a suitable comparison group. However, the primary purpose of the interviews was

to determine if the children with ALL had anything in common. We were able to rule out many factors that were not shared by all of the children.

Without a comparison group, judgement is required in deciding what the "significance" level or trigger point should be when examining the proportion of the cases that were exposed to each risk factor. This decision needs to be made separately for each factor being studied and is based on how strongly the risk factor is believed to be associated with the disease and on how common the factor is in the general population. For example, if we had found that all of the children in this study drank orange juice, we still would not consider drinking orange juice as a contributing factor to this cluster of ALL. Drinking orange juice has not been associated with developing ALL and nearly all children drink orange juice. For risk factors that are highly associated with the disease and are not common in the general population (such as, exposure to ionizing radiation), we would be suspicious if only a few cases reported being exposed.

The limitations of self-reported information are well known. Parents of children with serious diseases may be more likely to remember and report exposures to potentially hazardous substances than parents of children who are not sick. Additionally, the answers to some questions, such as eating habits, are harder to answer accurately as more time elapses between the event and the interview. With birth dates ranging from 1985 to 1992, some respondents were asked to recall information from more than 10 years ago.

CONCLUSIONS AND RECOMMENDATIONS

Although case series studies have limitations, the survey rules out some of the community's concerns about a common exposure. For example, there were not common parental employers or occupations; the children did not attend the same child care centers and schools; and the children did not eat locally caught fish or drink locally produced milk. Other factors were shared by two or three of the children (for example, parental smoking and prior miscarriage), but given the rates of these events in the general population, we did not find these common factors to be unusual. For reasons described in detail in the section on Water Quality, there is not a high likelihood that exposure to water contaminated with EDB and 1,2, DCP was a factor common to the children with ALL. The lack of these shared factors among this group of children, however, does not eliminate any of these causal factors for an individual child.

Four of the five children who participated in the survey lived near farming and had potential exposure to pesticides, either through proximity to farming or residential use of pesticides. However, these potential exposures may not be rare events for this geographic location. Additionally, several recent reviews suggest that parental occupational exposure to pesticides and home use of pesticides may be more important in the development of ALL than living in an agricultural area. Parents of only one child reported use of pesticides in the home and none of the parents were involved in agricultural work, suggesting that these two types of potential exposure to pesticides are not a factor in this cluster of ALL. Additional study of the relationship of potential pesticide exposure to the

development of childhood ALL is best conducted as a multi-site study enrolling, for example, children with leukemia from many areas across the United States.

Schottenfeld and Fraumeni state that there is historical interest in leukemia clusters. Several investigations show evidence that ALL clusters geographically, but scientists do not have an explanation for this phenomenon. For example, between 1961 and 1982, CDC investigated 41 leukemia clusters and did not discover a clear cause for any cluster[6]. One explanation is that cancer clusters are random in space and time. This may be due to a random clustering of individual risk factors. This cluster of cases in Whatcom County between 1992 and 1994 may well have been a random cluster. Concern for potential on-going common exposures is lessened by the findings that the rates of childhood ALL are not elevated in the 1993 through1995 and 1994 through1996 time periods.

We do not know why there were more cases of childhood leukemia than expected in the zip codes of interest between 1992 and 1994. Most children with leukemia do not have any known risk factors and the cause of their cancer remains unknown. Although many adult cancers can be prevented by lifestyle changes, there is currently no known way to prevent most childhood cancers, including most ALL. However, there are several public health recommendations related to findings in this survey that are helpful in lowering overall rates of cancer and other adverse health outcomes:

- DOH and HHS support the use of residential and commercial integrated pest management to reduce the potential for pesticide exposures.
- DOH and HHS recommend that owners of private wells routinely test their drinking water. Wells should be tested for coliform bacteria each year. Nitrates testing should be done at least once every three years. If nitrates are found in the water, testing should be repeated yearly to determine if the levels are changing. A pesticide analysis may be warranted every three to four years if the well is located near a known pesticide-contaminated area. If a well is found to contain levels of contamination above the maximum allowed level, a different source of water should be used or the water should be treated prior to use and the well should be tested annually. If low levels of contaminants that do not prevent the water from being used are present, the well should be monitored at approximately six-month intervals to establish the pattern of contamination during fluctuating water levels. HHS can assist with individual water-testing decisions.
- DOH and HHS support the recommendations of the National Cancer Institute to eat a healthy diet that includes least five servings of fruit and vegetables per day. This dietary habit may help protect children and adults from developing several types of cancer.
- DOH and HHS recognize the health risks of smoking in general, smoking during early pregnancy, and environmental tobacco smoke exposure. Therefore, we strongly urge all persons to stop smoking.

[6] Glyn G. Caldwell. Twenty-two years of cancer cluster investigations at the Centers for Disease Control. American Journal of Epidemiology 1990;132:S43-S47.

We do not recommend surveying a control series for the following reasons:

- We did not find unique patterns of exposure suggesting the need for further investigation in Whatcom County. Other than potential exposure to pesticides and farming, the children did not seem to share common factors. The pesticide exposures potentially shared by the children were not the exposures that may be most important (i.e., parents with occupational exposures) and home indoor use of pesticides. Investigating these potential exposures in more detail is best done as part of relatively large, multi-site studies capable of enrolling a large number of children.

- While the number of children with leukemia may be high for a small area, the number is too small to allow us to rule out factors with certainty. Finding no difference between cases and controls could be because there is really no difference or because the numbers are too small to allow us to detect subtle differences.

  For example, proximity to farming and potential exposure to pesticides were reported for four of the five children. If we interviewed parents of 15 children who did not have ALL, we would not find a statistically significant difference between the children with and without ALL if four or more children without ALL lived near farms or had potential exposure to pesticides. (We generally consider something to be statistically significant if the probability of observing the result by chance is less than 5%.) Given the extent of agriculture in the zip codes of interest and the broad definition of potential exposure to pesticides, it is likely that four or more children without ALL would also have these exposures.

  Without statistical significance, we might wonder whether finding 4 out of 5 cases compared to 4 out of 15 controls is important (i.e., do we lack statistical significance because we have small numbers or do we lack statistical significance because there really is no difference). While we might wonder about this, our ability to answer questions about what caused leukemia in Whatcom County would be limited. At best, we might recommend that proximity to farming or exposure to pesticides deserves further study. Because larger numbers enable researchers to be more certain about the importance of their findings, this type of study is best conducted as a multi-site study enrolling, for example, children with leukemia from many areas across the United States.

- Given the recent information from the cancer registry indicating no new cases in the selected zip codes of childhood ALL in 1995 and one new case in 1996, we are less concerned than previously about a potential on-going exposure in Whatcom County related to the development of childhood ALL.

To gain additional evidence for our judgements related to water quality, HHS tested two of the three private wells used by the three children. HHS was unable to obtain consent to test the third well. Results of these tests showed no

contamination with synthetic or volatile organic compounds, including EBD; 1,2, DCP; and DBCP. Details of this testing are available though HHS.

DOH will continue to monitor the number of cases of ALL in the area using WSCR data. DOH and HHS will continue to work on identifying, decreasing and eliminating contamination of groundwater in Whatcom County.

Other Sources of Information

Leukemia, Lymphomas, and Myeloma. Leukemia Society of America. <http://www.leukemia.org>.

Cancer Information: Specific Cancers. American Cancer Society. <http://www.cancer.org>.

CancerNet: Information: Patients and the Public, Health Professionals, and Basic Researchers. National Cancer Institute. <http://cancernet.nci.nih.gov>.

ATTACHMENT 1

Report on Childhood Leukemia and Lymphoma in Selected Zip Codes in North and West Whatcom County

Prepared by the Washington State Department of Health Office of Epidemiology (Kammy Johnson and Juliet VanEenwyk, 360-705-6047) and the Washington State Cancer Registry (Joe Campo, 360-664-2969) for the Whatcom County Health Department

Background

In response to a call from a citizen of Whatcom county, the Washington State Department of Health analyzed cancer incidence and hospitalization data to determine whether there was more childhood leukemia or leukemia and lymphoma combined in selected areas in north and west Whatcom county than in the rest of the state. We also compared the incidence rate of leukemia in the selected areas of Whatcom county to the incidence rate in other locations.

Cancer Incidence

The Washington State Cancer Registry collects information on all new cases of cancer diagnosed in Washington residents. The registry includes information on age at diagnosis, zip code of residence, and type of cancer. Using this information, we found the number of cases of childhood leukemia and lymphoma for the Custer (98240), Everson (98247), Ferndale (98248), Lynden (98264) and Sumas (98295) zip codes for 1992-1994. We compared the number of observed cases to the number of cases expected if rates in the 5 zip codes were the same as the rates in the state as a whole. Because it is natural for there to be variation in the number of cases over a three year period, we conducted a statistical test to determine whether the number of cases in the 5 zip codes was statistically significantly different than the expected number. The following table provides the results of these analyses.

Washington State Cancer Registry Incidence Data for 1992-1994
Custer (98240), Everson (98247), Ferndale (98248), Lynden (98264) and Sumas (98295)

	Age	Observed	Expected
Leukemia	0-4	5*****	0.9
	5-9	0	0.4
	10-14	1	0.3
	15-19	0	0.2
	Total (0-19)	6*****	1.7
Leukemia and Lymphoma	0-4	5*****	1.0
	5-9	0	0.5
	10-14	2	0.7
	15-19	0	0.8
	Total (0-19)	7	2.9
All Cancers	0-4	5	2.5
	5-9	0	1.5
	10-14	2	1.5
	15-19	0	2.3
	Total (0-19)	7	7.8

*****Statistically significant at $p < 0.05$, i.e. if there is really no difference between the observed and expected, we would expect this result to occur by chance less than 5 out of 100 times.

As can be seen from the previous table, there are statistically significantly more leukemia cases for children ages 0-4 years than expected. This increase causes the statistically significant increases for children ages 0-19 with leukemia and for children ages 0-4 years with leukemia and lymphoma.

Hospitalization Data

The Comprehensive Hospital Abstract Reporting System collects information on all hospitalizations in Washington, including patient's age at hospitalization, zip code of patient's residence, and reason for hospitalization. The dataset also includes a unique patient identifier so that hospitalizations can be unduplicated (i.e., we can count people rather than hospitalizations). Using this information, we identified the number of children ages 0 - 9 years who were residents of Custer (98240), Everson (98247), Ferndale (98248), Lynden (98264), and Sumas (98295) when hospitalized for leukemia and/or lymphoma from 1987 through 1996.

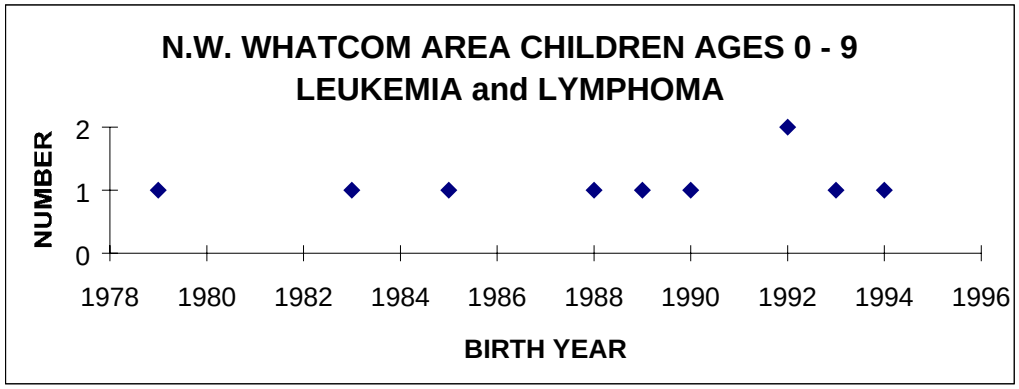
Nine cases of leukemia and one case of lymphoma were identified from the region during the 10 year period. The ages and years of diagnosis are shown below. As can be seen from that table, there are more cases in the last five years of the time period than in the first five years.

The number of leukemia and lymphoma cases by year and age group

	Year of first hospitalization									
Age Group	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0 - 4	1	0	0	0	0	2	1	1	0	2[a]
5 - 9	0	1	0	0	1	0	0	0	0	1
0 - 9	1	1	0	0	1	2	1	1	0	3[a]

[a]Includes one case of lymphoma

Consistent with the preceding table and incidence data which show that most leukemia and lymphoma in the area of concern occurs in children ages 0-4 years, the following table illustrates that the birth years for children hospitalized with leukemia and lymphoma between 1987 and 1996 are predominately after 1988.



We analyzed the hospitalization data in a manner similar to the incidence data, developing observed and expected numbers. As can be seen from the table on the following page, in the 1992-1996 time period, there are statistically significantly more children aged 0-4 years hospitalized with leukemia than expected. The increase in leukemia causes the statistically significant increase for children aged 0-4 years with leukemia and lymphoma. The table also shows that the number of hospitalizations is not elevated in the 5 zip codes in the earlier time period or for children aged 5-9 years.

Hospitalization for Leukemia and Lymphoma by Time Period and Age Group

	Years	Age group	Observed cases	Expected cases
Leukemia	1987 - 1991	0 - 4	1	1.4
	1992 - 1996		5*	1.5
	1987 - 1996		6	2.9
	1987 - 1991	5 - 9	2	1.1
	1992 - 1996		1	1.0
	1987 - 1996		3	1.9
Leukemia and lymphoma	1987 - 1991	0 - 4	1	1.6
	1992 - 1996		6*	1.7
	1987 - 1996		7	3.8
	1987 - 1991	5 - 9	2	1.5
	1992 - 1996		1	1.2
	1987 - 1996		3	2.6

*****Statistically significant at $p < 0.05$, i.e. if there is really no difference between the observed and expected, we would expect this result to occur by chance less than 5 out of 100 times.

Comparison of Incidence Rates for Leukemia

The following table presents the incidence rates for childhood leukemia in various geographic regions. The rate of leukemia for children aged 0 - 4 years in the selected Whatcom county zip codes is higher than the Seattle-Puget Sound, state and national rates for children of the same age group. However, the rate of leukemia in all of Whatcom county for this age group is not elevated when compared to the other geographic regions. All of the cases in Whatcom County are from the 5 zip codes.

Leukemia incidence rates per 100,000 children

Geographic area	Years	Age group	Rate	Data source
North and West Whatcom County[a]	1992-1994	0 - 4	**42***	WA State Cancer Registry
		5 - 9	0	
Whatcom county	1992-1994	0 - 4	16.2	WA State Cancer Registry
		5 - 9	3.2	
Seattle-Puget Sound[b]	1990-1994	0 - 4	8.0	NCI SEER[c] Website
		5 - 9	3.3	
Washington State	1992-1994	0 - 4	7.2	WA State Cancer Registry
		5 - 9	3.3	
United States	1990-1994	0 - 4	6.7	NCI SEER[c] Website
		5 - 9	3.5	

*****Significantly ($p < 0.05$) higher than the rates for the Seattle-Puget Sound Region, Washington state, and the United States.

[a] Zip codes for Custer (98240), Everson (98247), Ferndale (98248), Lynden (98264), and Sumas (98295).

[b] Whatcom, San Juan, Skagit, Island, Snohomish, King, Pierce, Thurston, Grays Harbor, Mason, Kitsap, Jefferson, and Clallam counties.

[c] Data from the National Cancer Institute's Surveillance, Epidemiology and End Results Canques program (http://www-seer.ims.nci.nih.gov/ScientificSystems/Canques7394/)

Conclusions

Data from both the Washington State Cancer Registry and the Comprehensive Hospitalization Abstract Reporting System support the conclusion that rates of leukemia in the five zip codes of interest in Whatcom County are higher than expected. Data from these systems also indicates that rates of leukemia in children older than 4 years and rates of lymphoma are not elevated.

For more information, contact Janet Davis, Whatcom County Health Department, 509 Girard Street, PO Box 935, Bellingham, WA 98227-0935 or (360) 676-6720.

Attachment 2: Questionnaire

Patient ID Code: _____

Timeline **Dx (__/__/__)**

Residence *(6 months or more, 2 years prior to birth through diagnosis)*						
Employers of those living for at least 4 months with child						
Mother (2 years prior to birth through diagnosis)						
Father (2 years prior to birth, if living with mother, through diagnosis)						
Other _____						
Other _____						
Other _____						
Other _____						
Other _____						
Other _____						
Other _____						
Other _____						
Other _____						

Washington State Department of Health
ALL Interview Form

Patient ID Code: _____

I would like to ask some questions about you just to know your relationship to _____ and to allow us to contact you again in case we have some additional questions. Is that all right with you? ☐ Yes ☐ No

(0.1) First Name	Last Name			
(0.2) Street Address, if different from child's address	City	State	Zip Code	(0.3) Phone Number

I would like to start by getting some basic information about _____.
Do I have the correct name? ☐ Yes ☐ No, *go to 0.4 and obtain correct information.*

(0.4) First Name	Middle Initial	Last Name

(0.5) **Does _____ live with you?**

☐ Yes ☐ No, *If no*, **What is _____'s current address and phone number?**

(0.6) Street Address	City	Zip Code	(0.7) County	(0.8) Phone Number

Patient ID Code

Interviewer		Phone Number
Title	Association	Interview Date

Section I - Adult Interviewee

(1.1) **What is your relationship to _____?**

☐ Mother ☐ Maternal Grandmother ☐ Maternal Grandfather ☐ Maternal Aunt ☐ Maternal Uncle ☐ Step Mother ☐ Other, please specify below

☐ Father ☐ Paternal Grandmother ☐ Paternal Grandfather ☐ Paternal Aunt ☐ Paternal Uncle ☐ Step Father _____

Section II - Child Identifying Information

(2.1) **Do I have the correct birthdate and sex?** ☐ Yes ☐ No, *go to 2.2 and obtain correct information.*

(2.2) **What is _____'s birthdate?**	(2.3) **What is _____'s sex?**

Birthdate: _____/_____/_____
Sex: _____

(2.4) **I understand that _____ is alive/died in _____/_____. Is this correct?**
Month Year

☐ Yes, *go to 2.5* ☐ No, *specify the correct information:* ☐ Alive ☐ Died _____/_____
Month Year

(2.5) **What is _____'s age?**

_____

(2.6) **What is _____'s race?** ☐ American Indian/Alaska Native ☐ African-American ☐ Other ☐ Asian/Pacific Islander ☐ Caucasian, *specify* _____

(2.7) **Is _____ of hispanic origin?** ☐ Yes ☐ No ☐ Unknown

Section III - Diagnosis Information

(3.1) **How old was _____ at the time of diagnosis?** _____ years old

(3.2) **Who was the primary doctor when _____ was first diagnosed with leukemia?**

Name Clinic Town

Patient ID Code

Now I will ask you about a wide variety of topics to see whether we can find patterns which may be related to the development of childhood leukemia. I will ask questions about a wide variety of topics because we do not know what causes cancer in children. You should not consider any of the specific topics covered in this interview to be directly related to the cause of your child's cancer.

Section IV - Medical History of Case

(4.1) **Before diagnosis, has _____ taken any home/folk medicines for at least one month during his/her lifetime?**

☐ Yes, *list below* ☐ No, *go to 4.2* ☐ Unknown

_____

_____

_____

(4.2) **Before diagnosis, did _____ ever receive radiation therapy or radioactive iodine treatment?**

If yes,

Age of child	Reason
_____	_____
_____	_____
_____	_____
_____	_____

(4.3) **Before diagnosis, did _____ ever have x-rays not related to his/her diagnosis?**

If yes, was this

(4.3.1) An MRI, CT or "CAT" scan? ☐ Yes ☐ No ☐ Unknown

(4.3.2) A regular diagnostic x-ray? ☐ Yes ☐ No ☐ Unknown

Patient ID Code

Section V - Residential History and Environmental Exposure of Mother, Father, and Child

Interviewer:

- *Show the interviewee the timeline on the first page of the interview form and obtain general information about residences of the child (birth to diagnosis), the child's mother (2 years prior to birth) and the child's father (2 years prior to birth).*
- *Then obtain information obout occupations of the child's mother (2 years prior to birth through diagnosis, if living with the child) and father (2 years prior to birth through diagnosis, if living with the child).*
- *Then obtain information about others who lived with the child for 4 months or more during the period from the child's birth to diagnosis.*

For the next few minutes, I will ask you to recall details about where _____ lived from _____'s birth to diagnosis and then where you lived from two years prior to _____'s birth to diagnosis. Then I will ask you where _____'s father lived from two years prior to _____'s birth to diagnosis. I am only interested in places where _____ or you or _____'s father lived for 6 months or more.

Ask the following questions for each residence and record responses in the following table.
Start with mother two years before birth of child.

5.1 **"Where was _____ living when he/she was diagnosed with leukemia?** or
"Where did he/she/you live before that?" *(street, if known, town, and state, when you get to child's birthplace ask about residences of biological mother and father for two years prior to birth)*

5.2 **"When did he/she/you live there?"** *(From year to year)*
For residences where the child lived between birth and diagnosis:
5.2.1 **"How many people live in this residence?"**
5.2.2 **"Not counting bathrooms, how many rooms were in the residence?"**

5.3 **"What is your main source of water for drinking?"**
5.3.1 *(if city/county or community well or spring,)* **"What is the name of that water system?"**
5.3.2 *(if private well,)* **"Have you had the well tested?"**
5.3.2.1 *(if yes,)* **"What were the results?"** *(Include Date, Who Tested, Results on back of residence page)*

5.4 **"What is your main source of water for cooking?"**
5.4.1 *(if different,)* **"What is the name of that water system?"**
5.4.2 *(if private well,)* **"Have you had the well tested?"**
5.4.2.1 *(if yes,)* **"What were the results?"** *(Include Date, Who Tested, Results on back of residence page)*

5.5 **"What is your main source of water for bathing?"**
5.5.1 *(if different,)* **"What is the name of that water system?"**
5.5.2 *(if private well,)* **"Have you had the well tested?"**
5.5.2.1 *(if yes,)* **"What were the results?"** *(Include Date, Who Tested, Results on back of residence page)*
5.5.3 *(ask for mother during pregnancy)* **"Did you usually bathe or shower at that residence?"**
5.5.4 *(ask for child at residences 2 years prior to diagnosis)* **"Did _____ usually bathe or shower at that residence?**

5.6 *(ask for child from birth to 1 year)* **"Did _____ drink formula while at this residence?"**
5.6.1 *(if yes,)* **"Did you usually make the formula with water?"**
5.6.1.1 *(if yes,)* **"What was the main source of water for the formula?"**

5.7 **"Were there any industries including commercial farming or berry farms near this residence?"**
(If response to 5.7 was yes,)
5.7.1 **"What was the name of the company?"**
5.7.2 **"How close was it to this residence?"**
5.7.3 **"What product/crop was manufactured/farmed by this company/farm?"**

5.8 **"Were any of the following substances used around this residence, either indoors or outside, including a garden?" [Insecticides, Rat Poison, Weed Killers]**

5.9 **"Were any of these substances used indoors at this residence?"**

5.10 **"Were any of these substances used outdoors at this residence?"**

5.11 **"Did you use a commercial lawn care company at this residence?"**
5.11.1 *(if yes,)* **"What was the name of the company?"**

5.12 **"Did you or anyone in your house use bug repellent such as OFF or Cutters?"**

5.13 **"Was aerial spraying done near this residence?"**
(If yes,)
5.13.1 **"If you know, what was the purpose of this spraying?"**

Patient ID Code

Section V - Residential History and Environmental Exposure of Mother, Father, and Child

☐ Child ☐ Mother ☐ Father

1	(5.1) Street	Town or City	State

(5.2) Years of Residence

From: _____ To: _____

(For residences where the child lived between birth and diagnosis)

(5.2.1) Number of people living in this residence.

(5.2.2) Not counting bathrooms, number of rooms in the residence.

(5.3) Water Supply for drinking
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.3.1) Name of the water system
☐ Unknown

(5.3.2) If private well, tested?
☐ Yes ☐ No

(5.3.2.1) If tested, results... ***Indicate Date, Who did Testing, Results on the back of this page***

(5.4) Water Supply for cooking
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.4.1) Name of the water system
☐ Unknown

(5.4.2) If private well, tested?
☐ Yes ☐ No

(5.4.2.1) If tested, results... ***Indicate Date, Who did Testing, Results on the back of this page***

(5.5) Water Supply for bathing
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.5.1) Name of the water system
☐ Unknown

(5.5.2) If private well, tested?
☐ Yes ☐ No

(5.5.2.1) If tested, results... ***Indicate Date, Who did Testing Results on the back of this page***

(5.5.3) Did you bathe or shower at residence?
☐ Yes ☐ No

(5.5.4) Did _____ bathe or shower at residence?
☐ Yes ☐ No

(5.6) Did _____ drink formula at this residence?
☐ Yes ☐ No

(5.6.1) Did you usually make the formula with water?
☐ Yes ☐ No

(5.6.1.1) Main source of water for the formula
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.7) Industries Nearby
☐ Yes ☐ No ☐ Unknown

(5.7.1) Company Name	(5.7.2) How close?	(5.7.3) Prod/Crop/Animal

(5.8) Substances used at Residence

☐ Insecticides (5.8.1)		☐ Rat Poison (5.8.2)		☐ Weed Killer (5.8.3)	
(5.9.1) Indoor	(5.10.1) Outdoor	(5.9.2) Indoor	(5.10.2) Outdoor	(5.9.3) Indoor	(5.10.3) Outdoor
☐ Yes ☐ No ☐ Unknown	☐ Yes ☐ No ☐ Unknown	☐ Yes ☐ No ☐ Unknown	☐ Yes ☐ No ☐ Unknown	☐ Yes ☐ No ☐ Unknown	☐ Yes ☐ No ☐ Unknown

(5.11) Lawn care company?
☐ Yes ☐ No ☐ Unknown

(5.11.1) Name of lawn care company

(5.12) Use bug repellant
☐ Yes ☐ No ☐ Unknown

(5.13) Aerial Spraying?
☐ Yes ☐ No ☐ Unknown

(5.13.1) Purpose of spraying

Patient ID Code

Section V - Residential History and Environmental Exposure of Mother, Father, and Child

☐ Child ☐ Mother ☐ Father

2	(5.1) Street	Town or City	State

(5.2) Years of Residence
From: _____ To: _____

(For residences where the child lived between birth and diagnosis)

(5.2.1) Number of people living in this residence.

(5.2.2) Not counting bathrooms, number of rooms in the residence.

(5.3) Water Supply for drinking
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.3.1) Name of the water system
☐ Unknown

(5.3.2) If private well, tested?
☐ Yes ☐ No

(5.3.2.1) If tested, results... ***Indicate Date, Who did Testing, Results on the back of this page***

(5.4) Water Supply for cooking
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.4.1) Name of the water system
☐ Unknown

(5.4.2) If private well, tested?
☐ Yes ☐ No

(5.4.2.1) If tested, results... ***Indicate Date, Who did Testing, Results on the back of this page***

(5.5) Water Supply for bathing
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.5.1) Name of the water system
☐ Unknown

(5.5.2) If private well, tested?
☐ Yes ☐ No

(5.5.2.1) If tested, results... ***Indicate Date, Who did Testing, Results on the back of this page***

(5.5.3) Did you bathe or shower at residence?
☐ Yes ☐ No

(5.5.4) Did _____ bathe or shower at residence?
☐ Yes ☐ No

(5.6) Did _____ drink formula at this residence?
☐ Yes ☐ No

(5.6.1) Did you usually make the formula with water?
☐ Yes ☐ No

(5.6.1.1) Main source of water for the formula
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.7) Industries Nearby
☐ Yes ☐ No ☐ Unknown

(5.7.1) Company Name	(5.7.2) How close?	(5.7.3) Prod/Crop/Animal

(5.8) Substances used at Residence

☐ Insecticides (5.8.1)
(5.9.1) Indoor: ☐ Yes ☐ No ☐ Unknown
(5.10.1) Outdoor: ☐ Yes ☐ No ☐ Unknown

☐ Rat Poison (5.8.2)
(5.9.2) Indoor: ☐ Yes ☐ No ☐ Unknown
(5.10.2) Outdoor: ☐ Yes ☐ No ☐ Unknown

☐ Weed Killer (5.8.3)
(5.9.3) Indoor: ☐ Yes ☐ No ☐ Unknown
(5.10.3) Outdoor: ☐ Yes ☐ No ☐ Unknown

(5.11) Lawn care company?
☐ Yes ☐ No ☐ Unknown

(5.11.1) Name of lawn care company

(5.12) Use bug repellant
☐ Yes ☐ No ☐ Unknown

(5.13) Aerial Spraying?
☐ Yes ☐ No ☐ Unknown

(5.13.1) Purpose of spraying

Patient ID Code

Section V - Residential History and Environmental Exposure of Mother, Father, and Child

☐ Child ☐ Mother ☐ Father

3	(5.1) Street	Town or City	State

(5.2) Years of Residence

From: _____ To: _____

(For residences where the child lived between birth and diagnosis)

(5.2.1) Number of people living in this residence.

(5.2.2) Not counting bathrooms, number of rooms in the residence.

(5.3) Water Supply for drinking
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.3.1) Name of the water system
☐ Unknown

(5.3.2) If private well, tested?
☐ Yes ☐ No

(5.3.2.1) If tested, results... ***Indicate Date, Who did Testing, Results on the back of this page***

(5.4) Water Supply for cooking
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.4.1) Name of the water system
☐ Unknown

(5.4.2) If private well, tested?
☐ Yes ☐ No

(5.4.2.1) If tested, results... ***Indicate Date, Who did Testing, Results on the back of this page***

(5.5) Water Supply for bathing
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.5.1) Name of the water system
☐ Unknown

(5.5.2) If private well, tested?
☐ Yes ☐ No

(5.5.2.1) If tested, results... ***Indicate Date, Who did Testing, Results on the back of this page***

(5.5.3) Did you bathe or shower at residence?
☐ Yes ☐ No

(5.5.4) Did _____ bathe or shower at residence?
☐ Yes ☐ No

(5.6) Did _____ drink formula at this residence?
☐ Yes ☐ No

(5.6.1) Did you usually make the formula with water?
☐ Yes ☐ No

(5.6.1.1) Main source of water for the formula
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.7) Industries Nearby
☐ Yes ☐ No ☐ Unknown

(5.7.1) Company Name	(5.7.2) How close?	(5.7.3) Prod/Crop/Animal

(5.8) Substances used at Residence

☐ Insecticides (5.8.1)		☐ Rat Poison (5.8.2)		☐ Weed Killer (5.8.3)	
(5.9.1) Indoor	(5.10.1) Outdoor	(5.9.2) Indoor	(5.10.2) Outdoor	(5.9.3) Indoor	(5.10.3) Outdoor
☐ Yes ☐ No ☐ Unknown	☐ Yes ☐ No ☐ Unknown	☐ Yes ☐ No ☐ Unknown	☐ Yes ☐ No ☐ Unknown	☐ Yes ☐ No ☐ Unknown	☐ Yes ☐ No ☐ Unknown

(5.11) Lawn care company?
☐ Yes ☐ No ☐ Unknown

(5.11.1) Name of lawn care company

(5.12) Use bug repellant
☐ Yes ☐ No ☐ Unknown

(5.13) Aerial Spraying?
☐ Yes ☐ No ☐ Unknown

(5.13.1) Purpose of spraying

Patient ID Code

Section V - Residential History and Environmental Exposure of Mother, Father, and Child

☐ Child ☐ Mother ☐ Father

4	(5.1) Street	Town or City	State

(5.2) Years of Residence
From: _____ To: _____

(For residences where the child lived between birth and diagnosis)

(5.2.1) Number of people living in this residence.

(5.2.2) Not counting bathrooms, number of rooms in the residence.

(5.3) Water Supply for drinking
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.3.1) Name of the water system
☐ Unknown

(5.3.2) If private well, tested?
☐ Yes ☐ No

(5.3.2.1) If tested, results... ***Indicate Date, Who did Testing, Results on the back of this page***

(5.4) Water Supply for cooking
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.4.1) Name of the water system
☐ Unknown

(5.4.2) If private well, tested?
☐ Yes ☐ No

(5.4.2.1) If tested, results... ***Indicate Date, Who did Testing, Results on the back of this page***

(5.5) Water Supply for bathing
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.5.1) Name of the water system
☐ Unknown

(5.5.2) If private well, tested?
☐ Yes ☐ No

(5.5.2.1) If tested, results... ***Indicate Date, Who did Testing, Results on the back of this page***

(5.5.3) Did you bathe or shower at residence?
☐ Yes ☐ No

(5.5.4) Did _____ bathe or shower at residence?
☐ Yes ☐ No

(5.6) Did _____ drink formula at this residence?
☐ Yes ☐ No

(5.6.1) Did you usually make the formula with water?
☐ Yes ☐ No

(5.6.1.1) Main source of water for the formula
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.7) Industries Nearby
☐ Yes ☐ No ☐ Unknown

(5.7.1) Company Name	(5.7.2) How close?	(5.7.3) Prod/Crop/Animal

(5.8) Substances used at Residence

☐ Insecticides (5.8.1)
(5.9.1) Indoor: ☐ Yes ☐ No ☐ Unknown
(5.10.1) Outdoor: ☐ Yes ☐ No ☐ Unknown

☐ Rat Poison (5.8.2)
(5.9.2) Indoor: ☐ Yes ☐ No ☐ Unknown
(5.10.2) Outdoor: ☐ Yes ☐ No ☐ Unknown

☐ Weed Killer (5.8.3)
(5.9.3) Indoor: ☐ Yes ☐ No ☐ Unknown
(5.10.3) Outdoor: ☐ Yes ☐ No ☐ Unknown

(5.11) Lawn care company?
☐ Yes ☐ No ☐ Unknown

(5.11.1) Name of lawn care company

(5.12) Use bug repellant
☐ Yes ☐ No ☐ Unknown

(5.13) Aerial Spraying?
☐ Yes ☐ No ☐ Unknown

(5.13.1) Purpose of spraying

Patient ID Code

Section V - Residential History and Environmental Exposure of Mother, Father, and Child

☐ Child ☐ Mother ☐ Father

5	(5.1) Street	Town or City	State

(5.2) Years of Residence
From: _____ To: _____

(For residences where the child lived between birth and diagnosis)

(5.2.1) Number of people living in this residence.

(5.2.2) Not counting bathrooms, number of rooms in the residence.

(5.3) Water Supply for drinking
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.3.1) Name of the water system
☐ Unknown

(5.3.2) If private well, tested?
☐ Yes ☐ No

(5.3.2.1) If tested, results... ***Indicate Date, Who did Testing, Results on the back of this page***

(5.4) Water Supply for cooking
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.4.1) Name of the water system
☐ Unknown

(5.4.2) If private well, tested?
☐ Yes ☐ No

(5.4.2.1) If tested, results... ***Indicate Date, Who did Testing, Results on the back of this page***

(5.5) Water Supply for bathing
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.5.1) Name of the water system
☐ Unknown

(5.5.2) If private well, tested?
☐ Yes ☐ No

(5.5.2.1) If tested, results... ***Indicate Date, Who did Testing, Results on the back of this page***

(5.5.3) Did you bathe or shower at residence?
☐ Yes ☐ No

(5.5.4) Did _____ bathe or shower at residence?
☐ Yes ☐ No

(5.6) Did _____ drink formula at this residence?
☐ Yes ☐ No

(5.6.1) Did you usually make the formula with water?
☐ Yes ☐ No

(5.6.1.1) Main source of water for the formula
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.7) Industries Nearby
☐ Yes ☐ No ☐ Unknown

(5.7.1) Company Name	(5.7.2) How close?	(5.7.3) Prod/Crop/Animal

(5.8) Substances used at Residence

☐ Insecticides (5.8.1)
(5.9.1) Indoor: ☐ Yes ☐ No ☐ Unknown
(5.10.1) Outdoor: ☐ Yes ☐ No ☐ Unknown

☐ Rat Poison (5.8.2)
(5.9.2) Indoor: ☐ Yes ☐ No ☐ Unknown
(5.10.2) Outdoor: ☐ Yes ☐ No ☐ Unknown

☐ Weed Killer (5.8.3)
(5.9.3) Indoor: ☐ Yes ☐ No ☐ Unknown
(5.10.3) Outdoor: ☐ Yes ☐ No ☐ Unknown

(5.11) Lawn care company?
☐ Yes ☐ No ☐ Unknown

(5.11.1) Name of lawn care company

(5.12) Use bug repellant
☐ Yes ☐ No ☐ Unknown

(5.13) Aerial Spraying?
☐ Yes ☐ No ☐ Unknown

(5.13.1) Purpose of spraying

Patient ID Code

Section V - Residential History and Environmental Exposure of Mother, Father, and Child

☐ Child ☐ Mother ☐ Father

6	(5.1) Street	Town or City	State

(5.2) Years of Residence
From: _____ To: _____

(For residences where the child lived between birth and diagnosis)

(5.2.1) Number of people living in this residence.

(5.2.2) Not counting bathrooms, number of rooms in the residence.

(5.3) Water Supply for drinking
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.3.1) Name of the water system
☐ Unknown

(5.3.2) If private well, tested?
☐ Yes ☐ No

(5.3.2.1) If tested, results... ***Indicate Date, Who did Testing, Results on the back of this page***

(5.4) Water Supply for cooking
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.4.1) Name of the water system
☐ Unknown

(5.4.2) If private well, tested?
☐ Yes ☐ No

(5.4.2.1) If tested, results... ***Indicate Date, Who did Testing, Results on the back of this page***

(5.5) Water Supply for bathing
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.5.1) Name of the water system
☐ Unknown

(5.5.2) If private well, tested?
☐ Yes ☐ No

(5.5.2.1) If tested, results... ***Indicate Date, Who did Testing, Results on the back of this page***

(5.5.3) Did you bathe or shower at residence?
☐ Yes ☐ No

(5.5.4) Did _____ bathe or shower at residence?
☐ Yes ☐ No

(5.6) Did _____ drink formula at this residence?
☐ Yes ☐ No

(5.6.1) Did you usually make the formula with water?
☐ Yes ☐ No

(5.6.1.1) Main source of water for the formula
☐ City or County ☐ Private Well ☐ Other, specify ☐ Don't know
☐ Community Well ☐ Spring _____

(5.7) Industries Nearby
☐ Yes ☐ No ☐ Unknown

(5.7.1) Company Name	(5.7.2) How close?	(5.7.3) Prod/Crop/Animal

(5.8) Substances used at Residence

☐ Insecticides (5.8.1)
(5.9.1) Indoor: ☐ Yes ☐ No ☐ Unknown
(5.10.1) Outdoor: ☐ Yes ☐ No ☐ Unknown

☐ Rat Poison (5.8.2)
(5.9.2) Indoor: ☐ Yes ☐ No ☐ Unknown
(5.10.2) Outdoor: ☐ Yes ☐ No ☐ Unknown

☐ Weed Killer (5.8.3)
(5.9.3) Indoor: ☐ Yes ☐ No ☐ Unknown
(5.10.3) Outdoor: ☐ Yes ☐ No ☐ Unknown

(5.11) Lawn care company?
☐ Yes ☐ No ☐ Unknown

(5.11.1) Name of lawn care company

(5.12) Use bug repellant
☐ Yes ☐ No ☐ Unknown

(5.13) Aerial Spraying?
☐ Yes ☐ No ☐ Unknown

(5.13.1) Purpose of spraying

Patient ID Code

Section VI - Occupation Information

I would like to ask you some questions concerning the occupations that you and _____'s father held in the period from two years prior to birth through the time of _____'s diagnosis. Then I would like you tell me about the occupations of other adults who lived in the household with _____ for at least 4 months from birth to diagnosis. Let's start with the jobs held by you. Try to remember all the jobs held, beginning with the last.

Interviewer: Ask the following questions and enter responses in the table below. Leave industrial, occupational, and agent classifications codes blank.

6.1 *(for the Mother)* **"Who were you employed by at the time of diagnosis?"** or
"Who were you employed by before this job?"
(for the Father and others) **"Who was he employed by at the time of diagnosis?"** or
"Who was he employed by before this job?"

6.2 *(Mother)* **"When did you begin to work for this employer?"** or
(Father/others) **"When did he begin to work for this employer?"**

6.3 *(Mother)* **"How many total years were you employed by this employer?"** or
(Father/others) **"How many total years was he employed by this employer?"**

6.4 **"What product or service did this employer produce or perform?"**

6.5 *(Mother)* **"What was your main job title and what activities or task did you do?"** or
(Father/others) **"What was his main job title and what activities or task did he do?"**

When the tasks are completed for a job then ask
(Mother) **"What job did you have before this one?"** or
(Father/others) **"What job did he have before this one?"**
Go to question 6.1 if there was another job.

6.6 **"During this time period, how many other people living in the house had this employer?**

Interviewer: After getting the mother's employment history...
Now, please tell me about the jobs held by the child's father. Try to remember all the jobs held, beginning with the last.

Interviewer: After getting the father's employment history...
Were there any other people living with you who held jobs from _____'s birth to his/her diagnosis?

☐ Yes, *ask questions 6.1 to 6.5 for all other persons living with the child for at least 4 months who held jobs from two years prior child's birth until his/her diagnosis.* ☐ No

Now, please tell me about those people and their jobs. Try to remember all the jobs held, beginning with the last.

Patient ID Code

Section VI - Occupation Information

Relationship to child	(6.1) Employer	(6.2) Year begun	(6.3) Total Years

(6.4) Products/Crops/Services	Industrial Code
(6.5) Main Job Title and task	Occup Code
(6.5) What other Job Title and task?	Occup Code
(6.5) What other Job Title and task?	Occup Code

(6.6) **During this time period, how many other people living in the house had this employer?**

Relationship to child	(6.1) Employer	(6.2) Year begun	(6.3) Total Years

(6.4) Products/Crops/Services	Industrial Code
(6.5) Main Job Title and task	Occup Code
(6.5) What other Job Title and task?	Occup Code
(6.5) What other Job Title and task?	Occup Code

(6.6) **During this time period, how many other people living in the house had this employer?**

Relationship to child	(6.1) Employer	(6.2) Year begun	(6.3) Total Years

(6.4) Products/Crops/Services	Industrial Code
(6.5) Main Job Title and task	Occup Code
(6.5) What other Job Title and task?	Occup Code
(6.5) What other Job Title and task?	Occup Code

(6.6) **During this time period, how many other people living in the house had this employer?**

Patient ID Code

Section VI - Occupation Information

Relationship to child	(6.1) Employer	(6.2) Year begun	(6.3) Total Years

(6.4) Products/Crops/Services	Industrial Code
(6.5) Main Job Title and task	Occup Code
(6.5) What other Job Title and task?	Occup Code
(6.5) What other Job Title and task?	Occup Code
(6.6) **During this time period, how many other people living in the house had this employer?**	

Relationship to child	(6.1) Employer	(6.2) Year begun	(6.3) Total Years

(6.4) Products/Crops/Services	Industrial Code
(6.5) Main Job Title and task	Occup Code
(6.5) What other Job Title and task?	Occup Code
(6.5) What other Job Title and task?	Occup Code
(6.6) **During this time period, how many other people living in the house had this employer?**	

Relationship to child	(6.1) Employer	(6.2) Year begun	(6.3) Total Years

(6.4) Products/Crops/Services	Industrial Code
(6.5) Main Job Title and task	Occup Code
(6.5) What other Job Title and task?	Occup Code
(6.5) What other Job Title and task?	Occup Code
(6.6) **During this time period, how many other people living in the house had this employer?**	

Patient ID Code

Section VI - Occupation Information

Relationship to child	(6.1) Employer	(6.2) Year begun	(6.3) Total Years

(6.4) Products/Crops/Services	Industrial Code
(6.5) Main Job Title and task	Occup Code
(6.5) What other Job Title and task?	Occup Code
(6.5) What other Job Title and task?	Occup Code

(6.6) **During this time period, how many other people living in the house had this employer?**

Relationship to child	(6.1) Employer	(6.2) Year begun	(6.3) Total Years

(6.4) Products/Crops/Services	Industrial Code
(6.5) Main Job Title and task	Occup Code
(6.5) What other Job Title and task?	Occup Code
(6.5) What other Job Title and task?	Occup Code

(6.6) **During this time period, how many other people living in the house had this employer?**

Relationship to child	(6.1) Employer	(6.2) Year begun	(6.3) Total Years

(6.4) Products/Crops/Services	Industrial Code
(6.5) Main Job Title and task	Occup Code
(6.5) What other Job Title and task?	Occup Code
(6.5) What other Job Title and task?	Occup Code

(6.6) **During this time period, how many other people living in the house had this employer?**

Patient ID Code

Section VI - Occupation Information

Relationship to child	(6.1) Employer	(6.2) Year begun	(6.3) Total Years

(6.4) Products/Crops/Services — Industrial Code

(6.5) Main Job Title and task — Occup Code

(6.5) What other Job Title and task? — Occup Code

(6.5) What other Job Title and task? — Occup Code

(6.6) **During this time period, how many other people living in the house had this employer?**

Relationship to child	(6.1) Employer	(6.2) Year begun	(6.3) Total Years

(6.4) Products/Crops/Services — Industrial Code

(6.5) Main Job Title and task — Occup Code

(6.5) What other Job Title and task? — Occup Code

(6.5) What other Job Title and task? — Occup Code

6.6) **During this time period, how many other people living in the house had this employer?**

Relationship to child	(6.1) Employer	(6.2) Year begun	(6.3) Total Years

(6.4) Products/Crops/Services — Industrial Code

(6.5) Main Job Title and task — Occup Code

(6.5) What other Job Title and task? — Occup Code

(6.5) What other Job Title and task? — Occup Code

(6.6) **During this time period, how many other people living in the house had this employer?**

Patient ID Code

Section VII - Child Care History

Interviewer: (Birth to diagnosis, include after school, vacation arrangements.)

I'm interested in where _____ was cared for outside of your home on a regular basis for at least six months up until the time he/she was diagnosed with leukemia.

Interviewer: Please ask the following questions and fill in the table.

(7.1) **Where did _____ go for child care?**	(7.2) **When?** *From* _____ *to* _____.	(7.3) **Address of childcare**
	Age (months) **From : _____ To:_____**	
	Age (months) **From : _____ To:_____**	
	Age (months) **From : _____ To:_____**	
	Age (months) **From : _____ To:_____**	
	Age (months) **From : _____ To:_____**	
	Age (months) **From : _____ To:_____**	
	Age (months) **From : _____ To:_____**	
	Age (months) **From : _____ To:_____**	

Patient ID Code

Section VIII - School Attendance

Interviewer: (list all school in each category)

I would like to know about the schools _____ has attended.

Interviewer: Please ask the following questions and fill in the table.

(8.1) **What is the name of the first (second, third, etc) preschool _____ attended?**

(8.2) **What age did he or she first attend there?**

(8.3) **What age did he or she last attend there?**

Interviewer: Ask the same questions for all preschools, elementary, junior high, and high schools.

Name	City	City Code	State	State Code	From (Age)	To (Age)
Preschool						
Elementary						
Junior High or Middle School						
High School						

Patient ID Code

Section IX - Community Activities

The kind of community activities _____ has participated in for at least 6 months in the past is important for us to know, such as church activities, sports, camp, scouts or other group programs.

Interviewer: Please ask the following questions and fill in the table.

(9.1) **What is the first (second, third, etc) activity _____ has participated in?**

(9.2) **Where did this activity take place?**

(9.3) **How old was _____ when he/she participated in this activity?**

Organization	Town	From (Age)	To (Age)

Patient ID Code

Section X - Play/Recreation Areas (out of doors)

Now, think about the places _______________ has played in his/her life.

Interviewer: Please ask the following questions and fill in the table.

(10.1) **Before ____________ began kindergarten, did he/she play in areas which were near factories or farms?**
If yes,
(10.1.1) **What did the industry manufacture?** *or* **What type of farm crop or animal?**

Interviewer: Ask the same questions for years after starting kindergarten.

(10.1) **Play Area**	(10.2) **Near Industry/ Farm**	(10.2.1) **Product/Crop/ Animal**	
Preschool			
______________________	☐ Yes, *go to 10.2.1* ☐ No ☐ Unknown	______________	
______________________	☐ Yes, *go to 10.2.1* ☐ No ☐ Unknown	______________	
______________________	☐ Yes, *go to 10.2.1* ☐ No ☐ Unknown	______________	
______________________	☐ Yes, *go to 10.2.1* ☐ No ☐ Unknown	______________	
After beginning kindergarten			(10.2.2) **What grade was _____ in?**
______________________	☐ Yes, *go to 10.2.1* ☐ No ☐ Unknown	______________	__________
______________________	☐ Yes, *go to 10.2.1* ☐ No ☐ Unknown	______________	__________
______________________	☐ Yes, *go to 10.2.1* ☐ No ☐ Unknown	______________	__________
______________________	☐ Yes, *go to 10.2.1* ☐ No ☐ Unknown	______________	__________
______________________	☐ Yes, *go to 10.2.1* ☐ No ☐ Unknown	______________	__________
______________________	☐ Yes, *go to 10.2.1* ☐ No ☐ Unknown	______________	__________
______________________	☐ Yes, *go to 10.2.1* ☐ No ☐ Unknown	______________	__________

Patient ID Code

Section X - Play/Recreation Areas (out of doors)

(10.3) **Before diagnosis, did _____ ever swim in streams, ponds, or ditches?**

☐ Yes, please describe ☐ No ☐ Unknown

Age of child	Body of water
_____	_____
_____	_____
_____	_____
_____	_____

(10.4) **During your pregnancy with _____, did you ever swim in streams, ponds, or ditches?**

☐ Yes, please describe ☐ No ☐ Unknown

Body of water
_____
_____
_____
_____

Patient ID Code

Section XI - Nutritional History

Next, we will discuss _____'s diet history.

(11.1) **Now, I will ask you about foods and beverages. Think about _____'s eating habits in the year before diagnosis. How often did _____ eat .....?**

Food Item	Per day	Per Week	Per Month	Per Year	Rarely/ Never		Food Item	Per day	Per Week	Per Month	Per Year	Rarely/ Never	
Fruit							**Hot Dogs**						
Fruit Juice							**Lunch Meats**						
Green salad							**Smoked or Cured Meats** (including ham, bacon, sausage, but not including lunch meats)						
Potatoes (not french fries, fried potatoes, or potato chips)							**Fish or Shellfish** Caught by you or a family member or a friend.						
Carrots							**Raw Milk**						
Vegetables (not carrots, potatoes, or salad)							**Vitamins**						

(11.2) *(If answer positive to fish or shellfish)* **"Where were the fish or shellfish usually caught or harvested?"**

(11.3) *(If answer positive to raw milk)* **"Where did you usually get the raw milk?"**
(interviewer prompt for specific farm or location of owner of source.)

(11.4) **"What brands of milk do you usually buy?"**
(check all that apply)

❒ Darigold ❒ Edaleen ❒ Haggen ❒ Market Choice
❒ Mega ❒ Vitamilk ❒ Western Family ❒ Wilcox

Patient ID Code

Section XII - Pregnancy

Now, I would like to ask you about your pregnancy history.

(12.1) **How many times have you been pregnant? Be sure to include all pregnancies even if they did not end with a birth.**

_____
Number of pregnancies

I'd like to ask you some questions about each pregnancy.

(12.2) **When did your _____ pregnancy end?**	(12.3) **What was the outcome of this pregnancy?**	(12.4) *If this pregnancy resulted in a live birth, still birth or miscarriage*, **Were there any birth defects?**	(12.5) *For live birth*, **Is the child alive?** *If yes*, **Is the child in good health?** *If no*, **What is not good about the child's health? When was this diagnosed?**
First pregnancy _____/_____ Month Year ☐ Single child ☐ Twins	☐ Live birth ☐ Stillbirth ☐ Miscarriage ☐ Induced abortion ☐ Ectopic or tubal (12.3.1) **How many months were you pregnant?** _____ **# of months**	☐ Yes, what kind? _____ _____ ☐ No ☐ Unknown	☐ Alive & healthy ☐ Alive & chronic condition What: _____ Date diagnosed: _____ ☐ Deceased **When did your child die?** _____ **Why did your child die?** _____ _____
Second pregnancy _____/_____ Month Year ☐ Single child ☐ Twins	☐ Live birth ☐ Stillbirth ☐ Miscarriage ☐ Induced abortion ☐ Ectopic or tubal (12.3.1) **How many months were you pregnant?** _____ **# of months**	☐ Yes, what kind? _____ _____ ☐ No ☐ Unknown	☐ Alive & healthy ☐ Alive & chronic condition What: _____ Date diagnosed: _____ ☐ Deceased **When did your child die?** _____ **Why did your child die?** _____ _____
Third pregnancy _____/_____ Month Year ☐ Single child ☐ Twins	☐ Live birth ☐ Stillbirth ☐ Miscarriage ☐ Induced abortion ☐ Ectopic or tubal (12.3.1) **How many months were you pregnant?** _____ **# of months**	☐ Yes, what kind? _____ _____ ☐ No ☐ Unknown	☐ Alive & healthy ☐ Alive & chronic condition What: _____ Date diagnosed: _____ ☐ Deceased **When did your child die?** _____ **Why did your child die?** _____ _____

Patient ID Code

Section XII - Pregnancy (continued)

Pregnancy Outcomes continued

(12.2) **When did your _____ pregnancy end?**	(12.3) **What was the outcome of this pregnancy?**	(12.4) *If this pregnancy resulted in a live birth, still birth or miscarriage*, **Were there any birth defects?**	(12.5) *For live birth*, **Is the child alive?** *If yes*, **Is the child in good health?** *If no*, **What is not good about the child's health? When was this diagnosed?**
Fourth pregnancy _____/_____ Month Year ☐ Single child ☐ Twins	☐ Live birth ☐ Stillbirth ☐ Miscarriage ☐ Induced abortion ☐ Ectopic or tubal (12.3.1) **How many months were you pregnant?** _____ **# of months**	☐ Yes, what kind? _____ _____ ☐ No ☐ Unknown	☐ Alive & healthy ☐ Alive & chronic condition What: _____ Date diagnosed: _____ ☐ Deceased When did your child die? _____ Why did your child die? _____ _____
Fifth pregnancy _____/_____ Month Year ☐ Single child ☐ Twins	☐ Live birth ☐ Stillbirth ☐ Miscarriage ☐ Induced abortion ☐ Ectopic or tubal (12.3.1) **How many months were you pregnant?** _____ **# of months**	☐ Yes, what kind? _____ _____ ☐ No ☐ Unknown	☐ Alive & healthy ☐ Alive & chronic condition What: _____ Date diagnosed: _____ ☐ Deceased When didyour child die? _____ Why did your child die? _____ _____
Sixth pregnancy _____/_____ Month Year ☐ Single child ☐ Twins	☐ Live birth ☐ Stillbirth ☐ Miscarriage ☐ Induced abortion ☐ Ectopic or tubal (12.3.1) **How many months were you pregnant?** _____ **# of months**	☐ Yes, what kind? _____ _____ ☐ No ☐ Unknown	☐ Alive & healthy ☐ Alive & chronic condition What: _____ Date diagnosed: _____ ☐ Deceased When didyour child die? _____ Why did your child die? _____ _____
Seventh pregnancy _____/_____ Month Year ☐ Single child ☐ Twins	☐ Live birth ☐ Stillbirth ☐ Miscarriage ☐ Induced abortion ☐ Ectopic or tubal (12.3.1) **How many months were you pregnant?** _____ **# of months**	☐ Yes, what kind? _____ _____ ☐ No ☐ Unknown	☐ Alive & healthy ☐ Alive & chronic condition What: _____ Date diagnosed: _____ ☐ Deceased When did your child die? _____ Why did your child die? _____ _____

Patient ID Code

Section XII - Pregnancy (continued)

Pregnancy Outcomes continued

(12.2) **When did your _____ pregnancy end?**	(12.3) **What was the outcome of this pregnancy?**	(12.4) *If this pregnancy resulted in a live birth, still birth or miscarriage*, **Were there any birth defects?**	(12.5) *For live birth*, **Is the child alive?** *If yes*, **Is the child in good health?** *If no*, **What is not good about the child's health? When was this diagnosed?**
Eighth pregnancy _____/_____ Month Year ☐ Single child ☐ Twins	☐ Live birth ☐ Stillbirth ☐ Miscarriage ☐ Induced abortion ☐ Ectopic tubal (12.3.1) **How many months were you pregnant?** _____ **# of months**	☐ Yes, what kind? _____ _____ ☐ No ☐ Unknown	☐ Alive & healthy ☐ Alive & chronic condition **What:** _____ **Date diagnosed:** _____ ☐ **Deceased** **When did your child die?** _____ **Why did your child die?** _____ _____
Ninth pregnancy _____/_____ Month Year ☐ Single child ☐ Twins	☐ Live birth ☐ Stillbirth ☐ Miscarriage ☐ Induced abortion ☐ Ectopic or tubal (12.3.1) **How many months were you pregnant?** _____ **# of months**	☐ Yes, what kind? _____ _____ ☐ No ☐ Unknown	☐ Alive & healthy ☐ Alive & chronic condition **What:** _____ **Date diagnosed:** _____ ☐ **Deceased** **When didyour child die?** _____ **Why did your child die?** _____ _____
Tenth pregnancy _____/_____ Month Year ☐ Single child ☐ Twins	☐ Live birth ☐ Stillbirth ☐ Miscarriage ☐ Induced abortion ☐ Ectopic or tubal (12.3.1) **How many months were you pregnant?** _____ **# of months**	☐ Yes, what kind? _____ _____ ☐ No ☐ Unknown	☐ Alive & healthy ☐ Alive & chronic condition **What:** _____ **Date diagnosed:** _____ ☐ **Deceased** **When did your child die?** _____ **Why did your child die?** _____ _____

Patient ID Code

Section XII - Pregnancy (continued)

Now, I'd like to ask you some additional questions about your pregnancy with _____.

(12.7) **Which pregnancy was that?** _____ *(Pregnancy number from previous section)*

(12.8) **Did you have any medical problems with or illnesses during this pregnancy?**

☐ Yes, *go to 12.9* ☐ No, *go to 12.12* ☐ Unknown

(12.9) **What was the illness or complication?**	(12.10) **During what month in the pregnancy did it occur?**	(12.11) **What treatments or medications were given?**

(12.12) **Did you have any x-rays during this pregnancy?**

☐ Yes, *go to 12.13* ☐ No ☐ Unknown

(12.13) **During what month(s) in the pregnancy did you have the x-rays?**	(12.14) **Why did you have the x-rays?**

(12.14) **What did _____ weigh at birth?** _____ **pounds** _____ **ounces**

Section XII - Pregnancy (continued)

(12.15) **Did you take any medications which you have not mentioned including over-the-counter medications, prescribed medications, or folk remedies during this pregnancy or in the year prior to preganancy?**

☐ Yes, *go to 12.15.1* ☐ No, *go to 12.16* ☐ Unknown

(12.15.1) **What were these medications and when did you/she take them?**

Medication	When	Medication	When

(12.16) **Did you ever have nitrous oxide ("laughing gas") during your pregnancy with _____?**

☐ Yes, *go to 12.17.1* ☐ No ☐ Unknown

(12.16.1) **In what month of the pregnancy with _____ did you have nitrous oxide?**

_____ Month

(12.17) **How old were you when _____ was born?**

_____ Age of the mother in years

(12.18) **How old was _____'s father when _____ was born?**

_____ Age of the father in years

(12.19) **Have you and your husband ever tried to have children, but were unable to do so?**

☐ Yes, *go to 12.19.1* ☐ No ☐ Unknown

(12.19.1) **When did you try to have children, but find you were unable to do so?**

_____

Patient ID Code

Section XIII - Familial Cancer

Now some questions concerning any of _____'s relatives who may have had cancer. Cancer includes cancer at any place in the body, such as lung, colon, stomach and so on. It also includes leukemias and lymphomas. Brain tumors are also often cancers..

(13.1) **Have you or _____'s mother, father, sisters or brothers had cancer?**

☐ Yes, please list below ☐ No ☐ Unknown

(13.1.1) **Which relative had cancer?**	Code	(13.1.2) **What type of cancer?**	Code	(13.1.3) **How old was he/she when the cancer was diagnosed?**	(13.1.4) **What year was that?**

(13.2) **Have any of _____'s other relatives including grandparents, aunts, uncles, or cousins had cancer?**

☐ Yes, please list below ☐ No ☐ Unknown

(13.2.1) **Which relative had cancer?**	Maternal	Paternal	Code	(13.2.2) **What type of cancer?**	Code	(13.2.3) **How old was he/she when the cancer was diagnosed?**	(13.2.4) **What year was that?**
	☐	☐					
	☐	☐					
	☐	☐					
	☐	☐					

Patient ID Code

Section XIV - Familial Birth Defects

Now, I would like to ask you about _____'s relatives who may have had birth defects (excluding brothers and sisters). Birth defects are things that people are born with even though they may not be diagnosed until later.

(14.1) **Have you or _____'s mother or father, or paternal half brother or sisters had defects at birth?**

☐ Yes, please list below ☐ No ☐ Unknown

(14.1.1) **Which relative had a birth defect?**	**Code**	(14.1.2) **What type of birth defect?**	**Code**

(14.2) **Have any of _____'s relatives had any of the following?**

(14.2.1) Down's Syndrome? ☐ Yes ☐ No ☐ Unknown ***(if yes)*** **Relationship to _____: _____**

(14.2.2) Bloom's Syndrome? ☐ Yes ☐ No ☐ Unknown ***(if yes)*** **Relationship to _____: _____**

(14.2.3) Fanconi's Syndrome? ☐ Yes ☐ No ☐ Unknown ***(if yes)*** **Relationship to _____: _____**

Patient ID Code

Section XV - Smoking

The next set of questions are about tobacco use.

Interviewer: Ask questions 15.1, 15.1.1, 15.1.2 only if child >= 10 years old.

(15.1) **Does _____ now or has he/she ever smoked?**

☐ Yes, *go 15.1.1* ☐ No, *go to 15.2* ☐ Unknown, *go to 15.2*

(15.1.1) **When did he/she begin smoking?**

_____ Age in years

(15.1.2) **Did he/she smoke at the time of diagnosis?**

☐ Yes ☐ No ☐ Unknown

(15.2) **From two years before _____'s birth through his/her diagnosis, did you smoke at least 100 cigarettes?**

☐ Yes, *go 15.2.1* ☐ No, *go to 15.3* ☐ Unknown, *go to 15.3*

(15.2.1) **Which years during that period did you smoke?**

_____

(15.3) **From two years before _____'s birth through his/her diagnosis, did _____'s father smoke at least 100 cigarettes?**

☐ Yes, *go 15.3.1* ☐ No ☐ Unknown

(15.3.1) **Which years during that period did he smoke?**

_____

Patient ID Code

Section XVI - Miscellaneous

(16.1) **As far as you know, has there ever been any intermarrying in your family (or in your husband's family? That is, cousins marrying cousins, for example?**

☐ Yes ☐ No ☐ Unknown

(If yes) **Please tell me the relationship of the people who intermarried and their relationship to_____.**

(16.1.1) **Relationship of people who intermarried.** (16.1.2) **Relationship to _____.**

_____ _____

_____ _____

_____ _____

(16.2) **Has _____ or _____'s mother or father ever been exposed to the chemical benzene?**

Relationship to _____

☐ Yes _____ ☐ No ☐ Unknown

(16.3) **Has anyone who has lived with _____ had a hobby or routinely done other activities, such as working on the car, which involved use of solvents or other chemicals not usually found in the house?**

☐ Yes, *go to 16.3.1* ☐ No ☐ Unknown

(16.3.1) **What chemicals?** (16.3.2) **How old was _____ when these were used?**

_____ _____

_____ _____

_____ _____

(16.4) **Has _____'s mother or father or siblings ever been told that they had a disorder of the body's immune system?**

Relationship to _____

☐ Yes _____ ☐ No ☐ Unknown

(16.5) **Have you or your child ever had any of the following medications prescribed?**

		Who		
phenylbutazone, butazolidin or azolid	☐ Yes	_____	☐ No	☐ Unknown
chloramphenicol or chloromycetin	☐ Yes	_____	☐ No	☐ Unknown

(16.6) **Do you have any thoughts concerning the cause of _____'s cancer?**

(16.7) **Is there anything else of importance we haven't asked you?**

Thank you, we appreciate the time and help you have given us with this study.

Patient ID Code

Section XVII - Interviewer's Remarks

The overall quality of this interview was:

☐ High quality ☐ Generally reliable ☐ Questionable ☐ Unsatisfactory

If you selected “Questionable” or “Unsatisfactory”:

The main reason for the questionable or unsatisfactory quality of information was because the respondent:

☐ Did not know enough information regarding the topic.

☐ Did not want to be more specific.

☐ Sounded bored or uninterested.

☐ Sounded upset, depressed or angry.

☐ Had poor hearing or speech.

☐ Sounded confused or distracted by frequent interruptions.

☐ Sounded inhibited by others around him or her.

☐ Sounded embarrassed by the subject matter.

☐ Sounded emotionally unstable.

☐ Sounded physically ill.

☐ Other (specify): _____

_____

_____

Use this space for any other comments you have which may affect the interpretation of the respondent's answers.

ATTACHMENT 3: Water Testing Information

The following information was abstracted from laboratory water testing accession forms used by the Washington State Department of Health, Drinking Water Division. The most commonly requested pesticide tests and other chemical analyses are represented. Note that each class of chemical or substance is listed by the EPA test method used for detection. Each class is then organized by the regulating agency if the substance is regulated. Other chemical evaluations are available. For more information, please contact Whatcom County Health and Human Services Environmental Health Division or visit their web site at www.nas.com/health/DrinkingWater.

INORGANIC CHEMICALS (IOCS) FOR NITRATES

EPA Regulated:
Nitrite – N
Total Nitrate / Nitrite

INORGANIC CHEMICALS (IOCS)

EPA Regulated:

Arsenic	Barium	Cadmium
Chromium	Mercury	Selenium
Beryllium	Nickel	Antimony
Thallium	Cyanide	Flouride
Nitrite-N	Nitrate-N	Total Nitrate/Nitrite
Iron	Manganese	Silver
Chloride	Sulfate	Zinc

State Regulated:

Sodium	Hardness	Conductivity
Turbidity	Color	Total Dissolved Solids
Lead	Copper	

Other (optional) IOCs:

Orthosphospate	Silica	Aluminum
Alkalinity	Magnesium	Calcium
Ammonia		

SYNTHETIC ORGANIC CHEMICALS (SOCs) SCREENED USING EPA TEST METHOD 504.1

EPA Regulated:

EDB	DBCP

State Unregulated:
1,2,3-Trichlorpropane

SYNTHETIC ORGANIC CHEMICALS (SOCs) SCREENED USING EPA TEST METHOD 531.1

EPA Regulated:

Carbofuran	Oxamyl

EPA Unregulated:

3-Hydroxycarbofuran	Aldicarb	Aldicarb Sulfone
Aldicarb Sulfoxide	Carbaryl	Methomyl

Other:

Baygon	Methiocarb

SYNTHETIC ORGANIC CHEMICALS (SOCs) SCREENED USING EPA TEST METHOD 515.1

EPA Regulated:

2,4 D	2,4,5 TP (Silvex)	Pentachlorophenol
Dalapon	Dinoseb	Picloram

EPA Unregulated:

Dicamba

State Unregulated:

2,4 DB	2,4,5 T	Bentazon
Dichlorprop	Acifluorfen	DCPA acid metabolites (A)
3,5 Dichlorobenzoic acid		

Other compounds (optional):

Chloramben	Hydroxydicamba	Nitrophenol

SYNTHETIC ORGANIC CHEMICALS (SOCs) SCREENED USING EPA TEST METHOD 525.2

EPA Regulated:

Endrin	Lindane	Methoxychlor
Toxaphene	Alachlor	Atrazine
Benzoapyrene	Chlordane	Diethylhexyladipate
Diethylhexylphthalate	Heptachlor	Heptachlor epoxide
Hexachlorobenzene	Simazine	Hexachlorocyclo-pentadiene
Pentachlorophenol		

EPA Unregulated:

Aldrin	Butachlor	Dieldrin
Metolachlor	Metribuzin	Propachlor
Flourene		

State Unregulated:

PCB	Arochlor 1221	Arochlor 1232
Arochlor 1242	Arochlor 1248	Arochlor 1254
Arochlor 1260	Bromacil	Arochlor 1016
Prometon	Terbacil	Diazinon
EPTC	Heptachlor Epoxide “B”	4,4 DDD
4,4 DDE	4,4 DDT	Cyanazine
Malathion	Parathion	Trifluralin
Acenaphthylene	Acenaphthene	Anthracene
Benzo (A) Anthracene	Benzo (B) Fluoroanthene	Benzo (G, H,I) Perylene
Benzo (K) Fluoranthene	Chrysene	Dibenzo (A,H) Anthracene
Fluoranthene	Phenanthrene	Ideno (1,2,3-cd) Pyrene
Pyrene	Benzyl Butyl Phthalate	Di-N-Butyl Phthalate
Diethyl Phthalate	Dimethyl Phthalate	Heptachlor Epoxide “A”

VOLATILE ORGANIC CHEMICALS (VOCs) SCREENED USING EPA TEST METHOD 524.2

EPA Regulated:

Vinyl Chloride	1,1 Dichloroethylene	1,1,1 Trichloroethane
Carbon Tetrachloride	Benzene	1,2 Dichloroethane
Trichloroethylene	1,4 Dichlorobenzene	Dichloromethane
trans-1,2-Dichloroethylene	cis-1,2-Dichloroethylene	1,2-Dichloropropane
Toluene	1,1,2-Trichloroethane	Tetrachloroethylene
Chlorobenzene	Ethylbenzene	Styrene
1,2 Dichlorobenzene	1,2,4 Trichlorobenzene	Total Xylenes
m/p Xylenes	o-Xylene	

EPA Unregulated:

Chloroform	Bromodichloromethane	Chlorodibromomethane
Bromoform	Chloromethane	Bromomethane
Chloroethane	1,1-Dichloroethane	2,2 Dichloropropane
1,1 Dichloropene	Dibromomethane	1,3-Dichloropropane
1,1,1,2-Tetrachloroethane	Bromobenzene	1,2,3-Trichloropropane
1,1,2,2-Tetrachloroethane	o-Chlorotoluene	p-Chlorotoluene
m-Dichlorobenzene	1,3-Dichloropropene	

State Regulated:

cis-1,3-Dichloropropene	trans-1,3-Dichloropropene	Fluorotrichloromethane
Bromochloromethane	Isopropylbenzene	n-Propylbenzene
1,3,5 Trimethylbenzene	tert-Butylbenzene	1,2,4-Trimethylbenzene
sec-Butylbenzene	p-Isopropyltoluene	n-Butylbenzene
Napthalene	Hexachlorobutadiene	1,2,3-Trichlorobenzene
EDB	DBCP	Dichlorodifluoromethane

RADIONUCLIDE ANALYSES

EPA Regulated:

Radium 226	Radium 226 + 228	Gross alpha
Gross beta	Tritium	Strontium 90
Cesium 134	Iodine 131	

EPA Unregulated:

Uranium	Radon